EMERGING INNOVATION SYSTEMS IN THE BALTIC STATES

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY AT THE UNIVERSITY OF ABERTAY DUNDEE

DUNDEE BUSINESS SCHOOL

UNIVERSITY OF ABERTAY DUNDEE

SEPTEMBER 2009

ABSTRACT

This study traces the development of innovative capacity in the three transition economies Estonia, Latvia, and Lithuania since their independence from the USSR. Using three different techniques, it explores the mechanisms of national competence-building and how this is influenced by the interaction of different economic agents, both foreign and domestic.

The first part of the project concerns itself with developing an econometric model to test factors such as FDI, market attractiveness, geographic distance and innovative capacity of the major investing countries for their influence on knowledge inflows over time (proxied by patent application in the Baltics originating abroad). Its aim is to explore what actually attracts knowledge into a country/ a system, thus acting as a counterbalance to the second part, which focuses on the mechanisms inside the host economy, while taking knowledge inflows as an independent variable.

The second part of the research analyses patenting dynamics in and around the Baltic States, drawing on an extensive patent database compiled from different sources, such as the EPO's, WIPO's, and national patent information sources. Knowledge flows into the Baltic host countries, knowledge generation within them, and the dissemination of internationally competitive innovations in the form of international patents coming from the three countries are put in context with an analysis of the institutional base of innovative activity in order to gain an overview of the structure and the patterns of developing innovative capacity. Furthermore, indices of relative technological specialisation were constructed for the Baltic States' patenting as well as for those countries that represent their largest foreign investors to assess the influence multinational enterprises exact on the formation of national innovation systems.

A third part of the study tackles possible innovation systems themselves by identifying spillovers through patent citation analysis, among other things. Focusing on international patents that originate in the Baltic States, which represent cutting-edge innovation with a greater chance for commercial success, interactions between applicants are monitored in order to identify central players in the countries' innovative activities.

The contributions to knowledge of this study are threefold: firstly, the theory of the Investment Development Path is applied to transition economies; secondly, proximity as a determinant of FDI and knowledge transfer is incorporated into and analysed within the existing theoretical framework; and thirdly, intangible assets are included into the IDP.

ACKNOWLEDGEMENTS

The first 'thank you' has to go to my Director of Studies for almost five years, Dr Pamela Siler, for essentially getting me here in the first place. Without her commitment, ceaseless support and constant poking holes into my arguments this work would not have been possible. I could not have wished for a better supervisor. She has steered me and the project successfully through sometimes turbulent stretches (and the peaceful ones as well). Thanks for kicking me every now and then; it is good to be believed in.

My second supervisor and close-to-the-finishing-line Director of Studies, Professor Mohamed Branine, provided constant support, both morally and hands-on, especially in the straits of administering and finalising the PhD, his help is greatly appreciated. Furthermore, his encouragement, advice, and occasional shared coffee break on the home straight have proved invaluable.

This PhD is partly financed by a grant from the European Patent Office's Research Fund, whom I thank for their generosity, and Fabienne Gauye in particular, who is a very nice person indeed to exchange emails with.

Many people made this endeavour not only easier, but also a great deal more enjoyable. It is impossible to name everyone, but some do need a mention. Dave Smith is probably the best desk mate one can think of, cheering me up and keeping the conversation running. Thanks to Sarah Hendry, Eileen Cook, Sabine Hotho, and Nat Jack in particular for listening all this time to my endless and often unfounded moaning and providing such sound advice both on professional and personal matters, and to Brian Ritchie for making me laugh and introducing me to real ale; Nikki McIntosh, Laura Ballester, Karen Elste, and Monica Münch for their friendship (who says you cannot find friendship on the internet??), Chloé Gallien and Pat Crosbie for being both great and supportive division leaders in their own right (I should mention Pam here as well, although I didn't have much dealings with her when she held that position), and everyone at the DBS School Office for answering countless, often utterly stupid, questions patiently and with a smile. Anne Weidmann and husband Christian accompanied us cheerily all the way and for a much longer time than just the PhD, as did Verena Lack and Robbie MacInnes. Karl-Friedrich always provided a shoulder to lean on. My thanks also go to Nina-Christine Bruckner, in place for the whole team at PolitikPla.net, for always helping with software, methodology, and other questions (and recommending some truly fantastic reads not connected with the Baltic rim, in Chris's case). Mo Egan and Vanessa Constant La Force did a lot to keep me sane in the last weeks before the viva voce, thanks for that – and the breakfast on the very day.

Thanks also to Eric Turnbull and the rest of the Copy Shop team for not only printing and binding this thesis, but also for responding with their usual lightning speed to 'could I have those handouts by yesterday'-requests.

My family is my inspiration. Without them, their undoubting belief in my abilities, their unconditional support in every respect, and their pride in seeing me, I would have never made it this far. My parents have formed me to become what I am (with which I am pleased), and my brother has taught me some good lessons along the way. I always knew where to turn to, and that means a lot.

My husband Guido was the first to push me to dare to dream and eventually live this dream. Whenever I am weak, he is strong; whenever I doubt, he reassures me; whenever I feel lost, he shows me the way (and formats my documents). His dedication defies description.

This thesis is dedicated to my mother, Elisabeth Junge. She couldn't make it all the way to see me graduate, yet I know she is with me.

Declaration

I hereby declare that I am the author of this thesis; that the work of which this thesis is a record has been done by myself, and that it has not previously been accepted for a higher degree.

Signe[redacted] Date: 20.11.2009

Certificate

I certify that Cornelia Junge has worked the equivalent of nine terms on this research and the conditions of ordinance 36 and related regulation have been fulfilled.

Signed[redacted] Date: 07/09/09

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ABBREVIATIONS

AcSc	Academy of Science, in patent category
AFA	Association of international research-based pharmaceutical manufacturers (Latvia)
BE	Belgium
CEE(C)	Central and Eastern Europe(an Countries)
CH	Switzerland
CORP	Corporate patent application
DE	Germany
DK	Denmark
DOM	Domestic firm, in patent category
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EE	Estonia
EEK	Estonian Kroon
EPC	European Patent Convention
EPO	European Patent Office
EU	European Union
FDI	Foreign Direct Investment
FE	Fixed Effects
FI	Finland
FOR	Foreign firm, in patent category
FR	France
GB	Great Britain
GDP	Gross Domestic Product
GLS	Generalised Least Squares
GOV	Government body, in patent category
ICT	Information and Communication Technology
IDP	Investment Development Path
IL	Israel
IMF	International Monetary Fund
IND	Individual, in patent category
IP	Intellectual Property
IPC	International Patent Classification
JP	Japan

LM	Lagrange Multiplier
LSDV	Least Squares Dummy Variables
LT	Lithuania
LV	Latvia
LZA	Latvian Institute for Organic Synthesis
MNE	Multinational Enterprise
NACE	Statistical Classification of Economic Activities in the European Community (from French: Nomenclature statistique des activités économiques dans la Communauté européenne)
NATO	North Atlantic Treaty Organisation
NBER	National Bureau for Economic Research
NIS	National Innovation System
NL	Netherlands
NO	Norway
NOI	Net Outward Investment
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
OLI	Ownership-Location-Internalisation paradigm (Dunning 1988)
OLS	Ordinary Least Squares
PCT	Patent Cooperation Treaty
PL	Poland
R&D	Research and Development
RE	Random-effects
RTA	Revealed Technological Advantage
RU	Russia
S&T	Science and Technology
SE	Sweden
SME	Small and medium-sized enterprises
SU	Soviet Union
TDP	Technology Development Path
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
UNI	University, in patent category
US	United States of America
US AppFT	US Patent Application Full-Text database (online)
US PatFT	US Patent Full-Text database (online)
USPTO	United States Patent and Trademark Office

USSR	Union of Soviet Socialist Republics
WEF	World Economic Forum
WIPO	World Intellectual Property Organization
WO	'World' Patent, country code for PCT patents

CHAPTER 1

INTRODUCTION

An idea that is developed and put into action is more important than an idea that exists only as an idea. (Buddha)

1.1 Overview

Unlike in the natural sciences, experiments are not conducted in social sciences, the simple reason being that it is impossible in a social context to create identical conditions under which the outcomes of different actions can be tested and compared. Economics, being a social science, is faced with the same constraint. This limitation makes assessments of for instance the impact of specific policies, investment, and innovation more complicated. By definition time cannot be reversed, and if an outcome is not the expected or desired one, the environment in which it took place has already changed as a result and the impact cannot be eliminated. Any countermeasure will have to take into account the changes that have occurred.

1.2 The Baltic States

In this context and while certainly not being labelled anything like an experiment, the three Baltic States Estonia, Latvia, and Lithuania come probably as close as possible to having a common starting point for subsequent individual development. When the three countries situated on the north-eastern shores of the Baltic Sea emerged from the collapsing USSR in 1991, they were as similar as distinct nations can probably get. The three small countries, situated next to one another, had before demanding and achieving their independence spent 46 years as republics of the Soviet Union, suffering almost identical histories of occupation, deportation, collectivisation, and Russifation (van Arkadie and Karlsson 1992). Even before that, they shared similar fates: having emerged from the First World War as newly independent countries, they had been annexed by the Third Reich as a consequence of the Molotov-Ribbentrop Pact and eventually occupied by and incorporated into the USSR. This is not to say that they are identical. Each country possesses its distinct language and national culture, and they have before the 20th century had varied and different forming histories. Lithuania, the largest, has almost 2.5 times the population of Estonia, the smallest of the three. Estonia is the only one with mineral resources worth mentioning. And Lithuania resisted Russification far more successfully than the other two, resulting in a far more homogenous populace. However, in 1991, when they started the process of transforming their Soviet-style command economies to market economies that would eventually be developed enough to make the accession to the EU possible in 2004, their situation was exceedingly similar.

Thus, they present an almost perfect case for a comparative study of the development of their respective innovative capacity, which in turn is a central 'ingredient' for the formation of a market-oriented, westernised economy.

1.3 Innovation as a Source of Growth

It is at this point important to distinguish between innovation and invention. Fagerberg (2005) points out that

> Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice. Sometimes, invention and innovation are closely linked, to the extent that it is hard to distinguish one from another. (p 4/5)

An economy's capacity to innovate and constantly upgrade its knowledge base is by now being widely considered as paramount to securing sustainable growth (see for instance Lall 1996, EC 2007, Breschi, Malerba, and Orsenigo 2000). Accordingly, much research has been conducted in recent years with the aim to understand knowledge creation, knowledge diffusion, and the building of national innovative capacity. The European Commission places some emphasis on this capacity, and regularly comments on member states' innovative performance.

1.4 Problem, Aim and Objectives of the Study

1.4.1 The Problem

Whether and how a country in transition can develop a sustainable knowledge base and indeed some form of innovation system to further its development and growth depends on many factors. While initial endowments matter, it is also knowledge transfers from outside the economy, mainly by developed source countries that can shape the path of development. In the case of Foreign Direct Investment (FDI), the Investment Development Path (IDP) model developed by Dunning (1981, 1988, 2001) argues that it will indeed be inward FDI that adds decisively to the development of a more advanced economic structure. It has since been widely accepted that FDI can act as a catalyst for economic development. But it is not only FDI itself that changes the host country, embedded in the Multinational Enterprise (MNE) presence are usually know-how and technology that spill over into the host economy and lead to learning by indigenous actors. Lall (1996) and others have argued repeatedly that even more important than the direct impact of FDI are the intangible assets that are embodied in it, and that these intangibles should be incorporated into the original IDP. This study attempts to do precisely that. Arguing that, with FDI, knowledge enters the Baltic host countries as well, it will examine these knowledge flows and how they shape Baltic domestic inventive activities in the course of transition. This study thus expands the theory of the IDP by incorporating the concepts of proximity and intangible assets, and furthermore presents a 'toolbox' of methods to achieve this theoretical addition.

1.4.2 Aim and Objectives

The central aim that this study has is the analysis of the formation of national innovative capacity in the Baltic States and how this is influenced by foreign activity in the country by MNEs through FDI. In combining several theoretical models and a variety of methodological approaches, knowledge flows in the Baltics States will be examined, and how these affect Baltic innovative performance, as measured in patent application counts. By examining these knowledge flows and knowledge generation within the Baltic States, the study will try to find evidence for emerging innovation systems in the three countries. The comparison between the countries is crucial in order to evaluate whether, despite the similar starting point described earlier, they develop differently and to see if possible differences can be attributed to differences in knowledge inflows, FDI, or absorptive capacity.

The objectives are as follows:

- To provide a theoretical framework and the appropriate methodological tools to explain and examine FDI and resulting knowledge flows to the Baltic States and assess the impact this has on the host countries' development of their own innovative capacity.
- To empirically test the influence several factors, like FDI, trade, geographical proximity and general innovativeness have on the actual size of knowledge inflows into Estonia, Latvia, and Lithuania.
- To analyse the knowledge inflows from the most important source countries in detail and provide a comprehensive picture of foreign patenting in the Baltic States.
- To examine indigenous patenting activities within the Baltic States, identify spillovers from the aforementioned knowledge inflows and assess the Baltic States' development of distinct technological specialisations.
- To finally assess the empirical evidence in the light of the theoretical framework developed and identify any, if existing, emerging innovation systems in the Baltic States.

1.4.3 Conduct of the Study

To achieve these objectives, a sequential approach to the subject is taken, which consists of the analysis of parts of the phenomenon from different angles. An array of methodological approaches will be employed; econometric, quantitative and qualitative approaches will complement each other and eventually build a consistent, complete and detailed picture of knowledge flows and generation in the Baltic States.

Patent data and FDI will be the main data used, complemented by several other indicators. For the specific aspect of patenting activities on the Baltic rim, a patent database is constructed to store and organise the detailed information that patent documents from different patent regimes contain.

1.5 The Structure of this Study

This study consists of eight chapters and several appendices. Following this introduction, Chapter 2 introduces the Baltic States Estonia, Latvia, and Lithuania. It outlines the situation of the countries and their transition process so far and details their suitability for a study of this kind. Chapter 3 constructs the theoretical framework within which the analysis is conducted, whereas Chapter 4 presents the appropriate methods to assess the assumptions presented in Chapter 3 and discusses the use of patent data in detail. Chapter 5, Chapter 6, and Chapter 7 are the ones dedicated to the actual analysis of knowledge dynamics in the Baltic States: Chapter 5 presents a panel data regression analysis that tests for the influence of FDI, trade, proximity, and innovativeness on bilateral knowledge flows to each Baltic State, proxied by patents extended from the source countries to the Baltics. These patent extensions or inflows are then examined in detail in Chapter 6 with respect to their institutional composition, technological content, and applicants. Chapter 7 turns to the analysis of the actual generation of knowledge within the Baltic States themselves, both by foreign and domestic applicants. Again, technological specialisations are investigated, as well as the type of and actual applicants, what prior knowledge patent applications rest on and whether spillovers take place. Chapter 8 summarises the major findings and conclusions and discusses the contributions the study makes to the body of existing knowledge, as well as highlighting the study's inevitable limitations and opportunities for further research.

CHAPTER 2

THE BALTIC STATES: A COUNTRY PROFILE

2.1 Introduction

The Baltic States Estonia, Latvia, and Lithuania were probably as similar to each other in 1991 as few other countries were at any time. Not only did they emerge from the USSR almost simultaneously in 1991, they are similar in many more aspects. This chapter highlights these similarities (and also the differences) and argues the case for taking the Baltics and their unique similarity as the basis for an in-depth analysis of one aspect of their transition since independence: the development of a knowledge-driven economy and a viable national innovation system (NIS). It is not the aim of this chapter to give a complete and all-over account of the Baltic States, however. Rather, the aspects that are most relevant for this particular study are presented, with a general overview of the region.

Section 2.2 starts with an overview: The Baltics' general situation with respect to geography and natural endowments, social structure and recent history are presented, followed by a much more in-depth examination of their transition process after they regained their independence in 1991. Given the subject and focus of this study, the development of FDI and international integration, as well as the development so far of innovative capacities is examined in detail and the starting points for the subsequent study identified.

A final section concludes and looks out to the chapters to come.

2.2 The Baltic States

The Baltic States Estonia, Latvia, and Lithuania are together part of what is commonly termed the Baltic Sea region, which in turn comprises all regions with direct access to the Baltic Sea; these are (going 'clockwise' around the sea) the Nordic countries Denmark, Norway, Sweden, and Finland, north-western Russia, the Baltic States themselves, northern Poland, and northern Germany. Most of these countries (the obvious exception being Russia and Norway) are today members of the European Union, the Baltic States (and Poland) having joined in 2004 after rapid transformation of their economies from command-and-control to market-driven systems. But the economic and political integration of the Baltic rim began in fact much earlier.

Over centuries, much of the region was integrated through intense trade links, with the Hanseatic League of merchant cities being the predominant network for much of the 13th to 17th centuries (van Arkadie and Karlsson 1992, Lieven 1994, Ketels and Sölvell 2004). The 20th century and the rise of the USSR made the formerly closely linked region take different developments, with the socialist part of the region re-entering the capitalist orientation of the whole region only after 1990 and the fall of the USSR in 1991. The Baltics, having been a part of the Soviet sphere of influence for almost six decades, have since striven to integrate themselves fully into Europe and the wider Western community. They have succeeded in this, entering the EU in 4004 as one of the most dynamic regions in Europe (Maheshwari and Robinson 2000)

2.2.1 Geography

The Baltic States are located on the Baltic rim to the north-west of the Baltic Sea, three small countries that are, partly due to their size, quite similar in their main characteristics.

Estonia, the smallest of the three with an area of 45,200 km^2 and currently about 1.4 million inhabitants, is the most northern one, sharing (sea) borders with Finland, Russia, and Latvia. The country is flat, with the highest point Suur Munamägi only rising 318m above sea level, and a plethora of about 1,500 islands off its coast. It is the only one of the three Baltic States to possess significant mineral resources, namely oil shale and phosphorite, both of which are exploited (van Arkadie and Karlsson 1992).

Latvia is in more than one sense the country in the 'middle' of the Baltics. Located between Estonia to the north and Lithuania to the south (the third neighbour is Belarus), it has a land area of 64,500 km^2 and a current population of about 2.4 million (both figures are between those of its neighbours). It is as flat as its northern neighbour with its highest 'peak' reaching 312m. Unlike Estonia, though, Latvia does not have any mineral resources of importance, its main natural resources are its forests, followed by peat and, interestingly, amber (Lieven 1994, van Arkadie and Karlsson 1992).

Both Latvia's and Estonia's capitals, Riga and Tallinn respectively, were major Hanseatic ports, with each country having a second Hanse city, namely Ventspils in Latvia and Tartu in Estonia and several smaller outposts.

Lithuania is the largest Baltic State by most measures. Its area of 65,200 km^2 is slightly larger than Latvia's; its population is highest with currently just under 3.5 million. It shares borders with Latvia, Russia (the Kaliningrad enclave), Poland, and Belarus. It is the 'flattest' of the three countries with a highest elevation of only 294m and has by far the shortest coastline, much of it sheltered from the open sea by the

Curonian peninsula. Like Latvia, it does not have any natural resources to speak of except timber (van Arkadie and Karlsson 1992). Vilnius, its capital and largest city, was never part of the Hanseatic League, being landlocked, however, Elbinga in the north served as a basis for the organisation, a counting house was established in Kaunas, and next-door Kaliningrad was a major port.

2.2.2 Recent History

The Baltic States achieved nationhood only in the early twentieth century, emerging from the turmoil of World War I and the Revolution in Russia. The idea of a (or rather three) Baltic nationality was a relatively new one at the time, being defined mostly through language and an almost mythical past (Lieven 1994). Before 1917, the Baltic region had been under Russian, Swedish, and German rule.

Of the three, Lithuania is the only one that can lay claim to a 'national' history of some kind, as the kingdom of Lithuania was one of Europe's largest nations in the late Middle Ages, comprising today's Lithuania, parts of Latvia, Belarus, and – through a union with it – most of Poland.

Nevertheless, all three countries developed their national identities in the second half of the 19th century, after they had been incorporated into the Russian Empire, partly in opposition to the empire's attempts of Russification. After the Russian Revolution in 1917 and the end of World War I in 1918, the Baltic States managed for the first time to become independent republics in their own right: the three countries declared their independence in 1918 and factually gained it after peace treaties with Russia were signed in 1920/21. While not identical, the histories of the Baltic States are somewhat similar in the interwar period, characterised by land reforms and failing democratic governments during the 1920s and a successive development towards nationalist governments in the 1930s. The Molotov-Ribbentrop pact that divided central Europe into German and Soviet spheres of influence brought the three countries into the Soviet Union in 1940 and again under German rule after the opening of the eastern front in 1941. The end of WWII saw the Baltics once again under Soviet occupation, where they were to remain as the Estonian, Latvian, and Lithuanian SSRs until 1991 (Lieven 1994, van Arkadie and Karlsson 1992). All three countries suffered severe losses to their indigenous populations through war, flight, and deportation in the 1940s; the pre-war populations were decimated by up to a third and at least partly replaced by an influx of ethnic Russians after WWII (van Arkadie and Karlsson1992).

In the 1980s, when the USSR started to unravel, the Baltic States once again began to assert their national identities, which resulted, after much upheaval, in their independence from the USSR in 1991 (Lieven 1994).

2.2.3 Social Structure

These population shifts and replacements have left a visible imprint on the Baltic societies today. While the Balts originally were three rather distinct peoples with their distinct languages and roots and formed fairly homogenous populations in their respective countries, being a part of the Soviet Union changed that significantly. By the time they re-emerged into independence in 1991, Estonia and Latvia in particular had large numbers of ethnic Russians in their populations. Ethnic Estonians constituted only 61.5% of the Estonian population in 1989, with Russians making up slightly more than 30% and other nationalities, such as Belarusians and Ukrainians being the remainder. In the cities and industrial districts the picture is even starker, with Estonians at times being less than half of the Population (van Arkadie and Karlsson 1992). In the same year, the share of ethnic Latvians in the Latvian population was only 52%, 34% were Russian. Lithuania did better in resisting the influx of Russians and counted only 9% of its population being Russian, 7% Polish, and 80% being ethnic Lithuanians (Lieven

1994). This ethnic composition of the Baltic States caused debate after independence with respect to citizenship of the newly independent republics – Estonia and Latvia both had reservations concerning citizenship of ethnic Russians, fearing to lose bits of their respective national identities. It also caused problems concerning the integration of ethnic Russians into the countries, as many of them did at the time of independence not even speak the respective national languages (Lieven 1994). While those issues still cause some tensions today, they do not form the basis for fears of immediate discontent within the states.

2.2.4 Economy

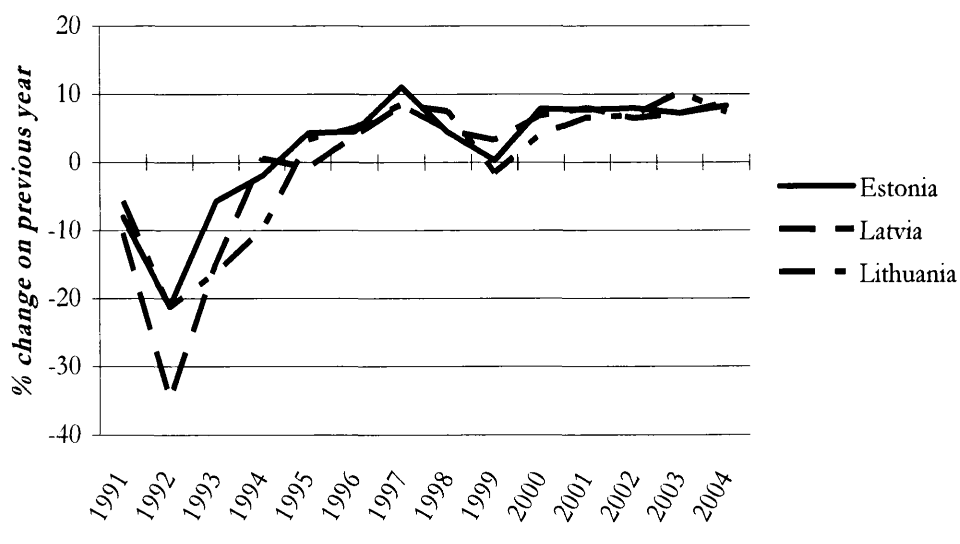
As early as 1950, the Baltic economies were fully integrated into the Soviet System and hardly different from elsewhere in the USSR. Land had been collectivised, almost all economic activity was centrally planned and administered from Moscow, and the once agrarian economies of the Baltic States had been transformed into industrialised societies highly dependent on inputs from other parts of the Union (van Arkadie and Karlsson 1992).

Thus, before the Baltic States can even tackle the formation of knowledge-driven economies, they need to develop and set up the institutions needed for a functioning market economy.

2.2.4.1 Post-Independence Recession

All three countries tried to open up their economies as quickly as possible to international investment after their independence in 1991, hoping that by integrating themselves into the international economy they could hasten their transition progress. However, having been part of the Soviet Union, rather than 'just' formally independent satellite states, they all encountered significant problems, partly due to rocketing inflation as a result of abolishing price controls (Nowak 2002). The Baltics, however, managed to curb inflation relatively quickly, although it remained high by Western standards throughout (IMF 2000). As in most transition economies after the fall of the USSR, output fell sharply in the first few years, with the Baltic States experiencing much deeper and more prolonged recessions than many other CEE countries that hadn't been part of the USSR. Estonia suffered five years of consecutive output decline, with a cumulative output decline of 35%, which still puts it in a slightly better position than the other two countries, with the corresponding figures for Latvia being six years and a 51% decline of output, and Lithuania five years of output decline and 44% cumulative output loss. Neither country had recovered its GDP level of 1990 by 2000 (World Bank 2002), but, thanks to strong growth rates, they did so shortly afterwards.

Figure 2.1: GDP Growth in the Baltic States, 1991-2004



(source: UNSTATS)

Berengaut and Elborgh-Woytek (2005) find in their study on the importance of the Soviet legacy for post-socialist CEE that, as actual Soviet republics, the Baltic States find it much harder than countries that were 'merely' satellite states to adjust to the new market system, as the Soviet 'ills' of excessive centralisation, waste and the complete absence of self-determination even on the micro level were much more ingrained.

After the opening of the Baltic borders, all three countries experienced a profound fall in their population numbers, as illustrated in Table 2.1 below.

Table 2.1: Population of the Baltic States, 1992-2004

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Estonia	1,533,091	1,494,128	1,462,514	1,436,634	1,415,594	1,399,535	1,386,156	1,375,654	1,369,515	1,364,101	1,358,644	1,353,557	1,349,290
Latvia	2,614,338	2,563,290	2,520,742	2,485,056	2,457,222	2,432,851	2,410,019	2,390,482	2,372,985	2,355,011	2,338,624	2,325,342	2,312,819
Lithuania	3,700,114	3,682,613	3,657,144	3,629,102	3,601,613	3,575,137	3,549,331	3,524,238	3,499,536	3,481,292	3,469,070	3,454,205	3,435,591

(Source: Eurostat)

Most of these losses were due to younger people seeking employment and education in the west; they were not compensated by an influx of expatriates returning to their home countries (which happened particularly in the earlier years of transition). Over the time period under examination in this study, Estonia experienced the greatest net decrease of 12%, Latvia's population shrank by 11.5%, and Lithuania's by 7.1%.

With FDI flowing into the countries and efforts by the governments to create a favourable environment for both foreign and domestic firms, the positions of the Baltic States have, over the years, improved, often significantly, as Table 2.2 below illustrates. The World Economic Forum's annual Global Competitiveness Report chart the world's countries' economic performance and business environment based on 'hard' data as well as on one of the most comprehensive surveys of business worldwide. The table presents the main indices together with a selection of items from the actual survey that are most important for the attraction of foreign firms and the development of a favourable seeding ground for the development of innovative capacity.

Table 2.2: The Baltic States positions in the Global Competitiveness Report over time

Item Title	Country	Rank 02/03	Rank 04/05	Rank 05/06	Item No. 02/03	Item No. 04/05	Item No. 05/06
Growth competitiveness index	Estonia	26	20	20			
	Latvia	44	44	44	n/a	n/a	n/a
	Lithuania	36	36	43			
Business competitiveness index	Estonia	30	27	26			
	Latvia	45	49	48	n/a	n/a	n/a
	Lithuania	40	36	41			
Technology index	Estonia	14	15	18			
	Latvia	29	36	38	n/a	n/a	n/a
	Lithuania	40	33	42			
Public institutions index	Estonia	28	26	25			
	Latvia	52	52	50	n/a	n/a	n/a
	Lithuania	36	43	44			
Macroeconomic environment index	Estonia	46	30	30			
	Latvia	55	37	38	n/a	n/a	n/a
	Lithuania	45	33	39			
Access to credit	Estonia	3	4	7			
	Latvia	9	22	13	2.05	2.07	2.07
	Lithuania	12	8	5			
Impact of rules on FDI	Estonia		18	8			
	Latvia		67	55	n/a	2.16	2.10
	Lithuania		62	60			
Technological sophistication	Estonia	28					
	Latvia	46			3.01	n/a	n/a
	Lithuania	62					
Technological Readiness	Estonia		30	27			
	Latvia		63	60	n/a	3.01	3.01
	Lithuania		64	66			
Firm-level innovation	Estonia	60					
	Latvia	26			3.02	n/a	n/a
	Lithuania	59					
Firm-level technology absorption	Estonia	13	22	35			
	Latvia	39	53	52	3.03	3.02	3.02
	Lithuania	33	36	41			
Prevalence of foreign technology licensing	Estonia	52	49	46			
	Latvia	21	60	68	3.05	3.03	3.03
	Lithuania	58	44	61			
FDI and technology transfer (= FDI as a source of technology)	Estonia	9	9	13			
	Latvia	25	46	50	3.04	3.04	3.04
	Lithuania	47	39	73			
Quality of scientific reseach institutions	Estonia	25	36	33			
	Latvia	46	77	73	3.06	3.05	3.05
	Lithuania	33	29	40			
University - industry research collaboration	Estonia	30	37	34			
	Latvia	48	[illegible]	61	3.09	3.08	3.07
	Lithuania	53	36	47			
Brain drain	Estonia	32	27	48			
	Latvia	53	51	67	3.13	4.12	4.08
	Lithuania	62	68	77			
Efficiency of legal framework	Estonia	29	24	33			
	Latvia	50	64	61	6.02	6.02	6.02
	Lithuania	60	62	75			
Intellectual property protection	Estonia	31	29	35			
	Latvia	56	72	61	6.04	6.04	6.04
	Lithuania	57	61	69			
Intensity of local competition	Estonia	45	38	18			
	Latvia	32	34	64	8.01	7.01	7.01
	Lithuania	22	30	39			
Extent of locally based competitors	Estonia	38	27				
	Latvia	73	46		8.02	7.02	n/a
	Lithuania	36	29				
Extent of market dominance	Estonia		6	51			
	Latvia		30	53	n/a	7.03	7.03
	Lithuania		38	67			
Buyer sophistication	Estonia	30	28	39			
	Latvia	53	57	59	9.01	8.01	7.04
	Lithuania	66	42	73			
Local supplier quality	Estonia	39	37	34			
	Latvia	51	46	44	9.03	8.03	7.06
	Lithuania	40	35	38			
State of cluster development	Estonia	74	78				
	Latvia	56	72		9.06	8.06	n/a
	Lithuania	34	52				
Extent of collaboration among clusters	Estonia	57	59				
	Latvia	36	53		9.07	8.07	n/a
	Lithuania	40	42				
Nature of competitive advantage	Estonia	61	73	61			
	Latvia	56	74	58	10.01	9.01	8.01
	Lithuania	48	52	57			
Capacity for innovation	Estonia	34	30	30			
	Latvia	39	49	51	10.04	9.04	8.03
	Lithuania	37	44	46			
Production process sophistication	Estonia	27	36	34			
	Latvia	47	54	54	10.06	9.06	8.05
	Lithuania	34	42	40			
Control of international distribution	Estonia	61	81	62			
	Latvia	67	60	72	10.09	9.09	8.08
	Lithuania	32	37	52			
	Sweden	14	6	14			
Foreign ownership restrictions	Estonia		29	19			
	Latvia		45	46	n/a	9.23	8.22
	Lithuania		55	55			

(WEF 2001, 2002, 2004, 2005)

The right column identifies the items from the overall questionnaire, where they are available, as the survey questions are changing over time.

While the Baltics' position on the whole has often improved or at least stayed fairly stable, it becomes clear that several issues still need to be addressed to improve the environment in which innovation is supposed to take shape. Most items related to technology transfer and research co-operation are, particularly in Latvia and Lithuania, still rather weak and overall confirm the EC's assessment of the Baltic's NISs as still underperforming. This is at least partly due to the problems the countries experienced with respect to build strong, competent, and viable institutions – a shortcoming the OECD (2000) criticises explicitly.

Pissarides (1999) identifies small and medium-sized enterprises as the sector of transition economies with the greatest potential for fostering and speeding up the transition process, as they tend to be the most dynamic firms. However, it is particularly SMEs that suffer from unstable or unsophisticated credit markets and a lack of access to capital. All Baltic States have undertaken efforts to address this issue, but have had only limited success so far, as their rankings' persistence in the Global Competitiveness Reports (WEF 2002, 2005) attests.[1]

Still, Burgess, Fabrizio, and Xiao (2004) find that the Baltic States are reasonably well on track in their transition process and have performed well between independence in 1991 and EU accession in 2004. The IMF (2000) supports this when commenting favourably on firm implementation of reforms and a higher commitment to macroeconomic stabilisation than elsewhere in the former Soviet Union. Facchini and

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[1] In the Global Competitiveness Report 2002-2003, the Baltics rank #25 (Estonia), #30 (Latvia), and #19 (Lithuania) for the item 'Ease of access to loans', and #24 (Estonia), #39 (Latvia), and #27 (Lithuania) for 'Venture capital availability'. In the Report for 2005-2006, they rank #38 (Estonia), #44 (Latvia), #10 (Lithuania) and #34 (Estonia), #55 (Latvia), #28 (Lithuania) respectively.

Segnana (2003) however argue that, compared to the rest of CEE, the Baltics do lack somewhat behind.

2.2.4.2 Privatisation of State-Owned Enterprises

The Baltic economies had been fully integrated into the USSR's economic system, which basically means that they did not function as national economies, but their state factories would serve the whole Soviet Union, resulting in problems very similar to those experienced by their Science and Technology systems (S&T) highlighted below: a high degree of vertical integration, but hardly any horizontal co-ordination between firms.

All three Baltic States committed themselves initially to returning property to former owners, where they existed; a scheme that proved enormously difficult to implement (Lieven 1994). Still, as early as 1992, major steps had been taken to privatise state-owned enterprises, whether through investment cheques or direct sales of enterprises (beginning with the smallest), to counteract and stall 'spontaneous' privatisation, where the management of state enterprises or other insiders simply took over the firm before any regulated process could start. Privatisation worked best in services (many major banks were bought and consolidated by Scandinavian banks during the 1990s); heavy industry proved more difficult to pass into private hands, as the technology was often hopelessly outdated by western standards.

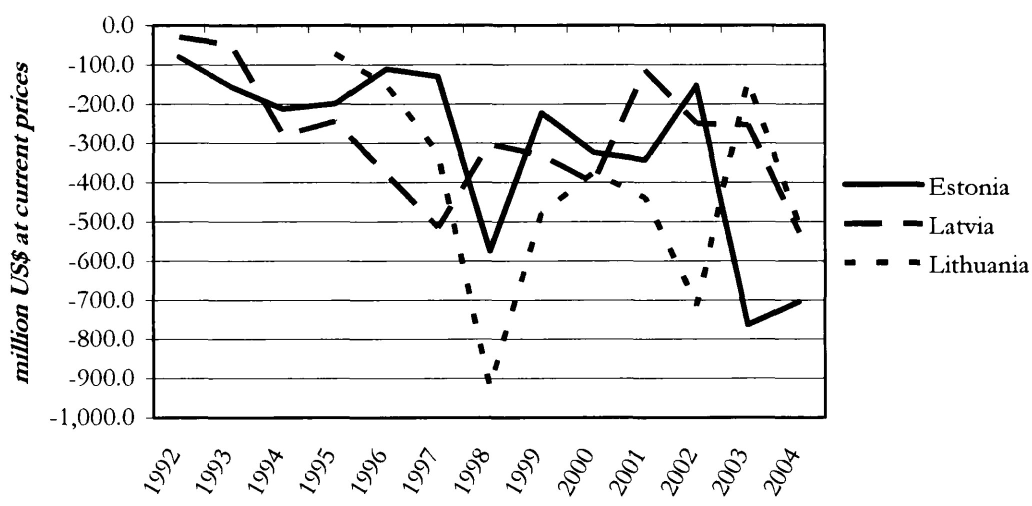
The strategies employed by the three countries have differed, though. Estonia aimed from very early on at selling state-owned enterprises directly to (foreign) investors, who would give a strategic impetus to the firms' development. Lithuania, attempting a more equity-oriented take, opted for vouchers, which would create purchasing power within its own population. Latvia, again seeking middle ground, went for direct sales like

Estonia, yet seemingly found it harder to prevent insider takeovers or spontaneous privatisation to begin with (World Bank 2002).

2.2.4.3 FDI and Trade

Figure 2.2 illustrates the Baltic States' net outward investment (NOI) position (outward FDI minus inward FDI) in the time under investigation in this study.

Figure 2.2: The Baltic States' NOI position, 1992-2004



(Source: UNCTAD)

The first wave of FDI, right after independence, came almost exclusively from the nearby Nordic countries (Johanson 2002). With respect to source countries of FDI, it is especially striking to observe that each country is 'linked' to one predominant host country through its FDI. Most FDI in Estonia has flown in from Finland, and at the same time Finland is also the most relevant recipient of Estonian FDI (IMF 2003a). In 2000, the largest source countries of FDI for Estonia were, measured by FDI stock, Sweden and Finland, followed by Norway, the US, Denmark, Germany, and the UK (OECD 2001a). In 2000, the largest foreign (non-bank) affiliates in the country (ranked by sales) were Eesti Telekom (Finland/ Sweden), Kreenholmi Valduse AS (a textiles firm from Sweden), the conglomerate Tolaram (Singapore), and foodstuffs producer Rakvere Lihakombinaat AS (Finland) (UNCTAD 2001a).

Lithuanian inward FDI is mostly from Denmark, which means that in 2000, the largest inward FDI stock has been of Danish origin, followed by the US, Sweden, and interestingly, Estonia (OECD 2001b). This is only a snapshot, however, as Denmark has taken over the lead from Sweden which again had overtaken the US as the strongest investor (IMF 2003b). This can be explained, though, by other factors like a relatively large Lithuanian community in the US and Swedish construction work in the telecommunications sector (EBRD 2001). The largest foreign firms not from the banking sector in Lithuania in 2000 were petro-chemical Mazeikiu Nafta AB (US), Lietuvos Energija AB (Sweden), and Lietuvos Telekomas AB (Finland/ Sweden) (UNCTAD 2001c).

The picture is a bit more blurred for Latvia, however. Although for the first ten years of the transition process Denmark seems to have taken the lead in investing there, no country has evolved the one dominant investor and by now Sweden is the strongest investing country. But this lead is a narrow one: accumulated FDI from Sweden accounts for 13.3%, but closely followed by German (12.7%) and Danish (11.7%) FDI (IMF 2003c). Here, the three largest non-bank foreign affiliates were Lattelekom SIA (Finland), gas-provider Latvijas Gaze AS (Germany/ Russia), and Latvijas Mobilais Telefons SIA (Finland/ Sweden) (UNCTAD 2001b).

Clearly, infrastructure-related FDI still dominates in the Baltic States to some extent, given their need for upgrading, yet the largest foreign investments are often to be found in the banking and financial sector, while the petro-chemical industry and more generally low-tech production like wood, apparel, and foodstuffs are targeted industries in the secondary sector (UNCTAD 2001a, b, c).

Boudier-Bensebaa (2008) places all CEECs into the first or second Stage of the IDP[2], and the NOI position of the Baltics seems to confirm this. Still, while the NOI position is negative throughout, it is also very unstable, thus making a direct placement difficult for the moment. Additionally, Facchini and Segnana (2003) find that in transition economies, most FDI is still geared towards production and attracted by differences in labour costs between source and host country.

Ghauri and Holstius (1996) find that, contrary to MNEs' experience in developed host countries, Norwegian firms that are active in the Baltic States face more difficulties in later phases of their involvement there, rather than in the early phases. They attribute this finding to problems in the matching process that precedes market entry: While at the macro level (government, industry bodies, etc) every effort is made in the Baltics to attract foreign firms, the actual partners with whom day-to-day business is conducted are far more difficult to deal with. Yet it is not only the investors that experience problems, but the host economy can also experience difficulties caused by FDI. Vissak and Roolaht (2005) describe several damaging effects of FDI in Estonia, where spillovers did not happen because of low-tech FDI, domestic firms were crowded out, or firms failed because of a lack of long-term strategy and commitment from investors.

Kozminski and Yip (2000) argue that the main advantages of the Baltic States as hosts for FDI are their favourable location and logistic advantage when it comes to distribution across CEE, overall good infrastructure, and their low labour costs. Their attractiveness for FDI should, by all means, increase further with ever deeper integration within Europe (Bevan, Estrin, and Grabbe 2001).

Looking at trade figures, the picture hardly changes, as Figure 2.3 below illustrates quite clearly.

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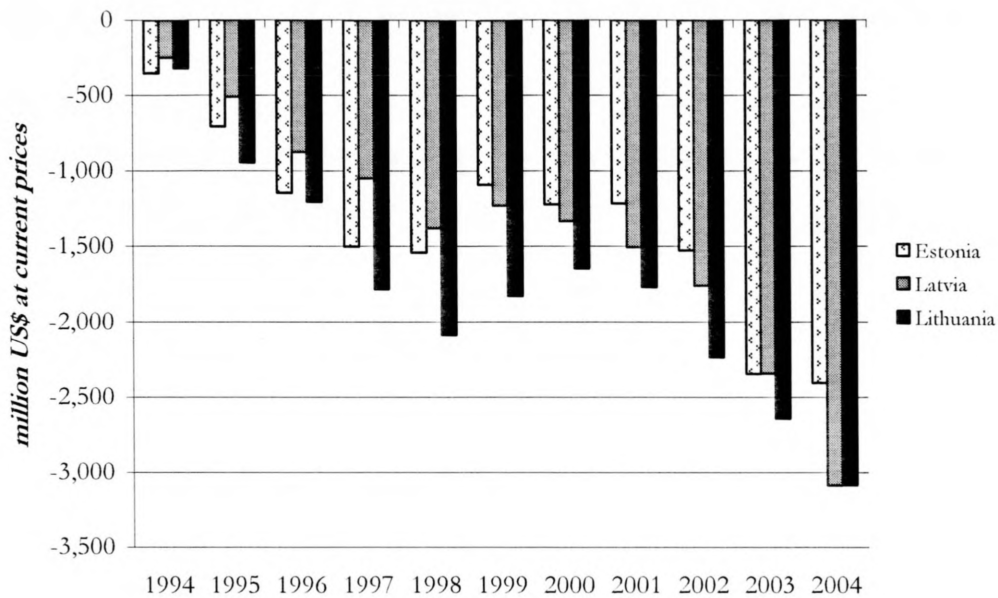
[2] The theory of the Investment Development Path (IDP) is detailed in Chapter 3.

Figure 2.3: Trade balance of the Baltic States



(Source: WTO)

Due to the virtual collapse of the Baltic economies in the first years of independence, they all still import more than they export. However, as Lankhuizen (2000) in her study of the countries' trade patterns, points out that while most trade is still concentrated in low-tech sectors and goods, the countries can and should aim for trade in more high-tech fields. While not concentrating on trade, this study will look at the Baltic States' potential to do this by developing first absorptive and then innovative capacity.

2.2.4.4 Innovation

In the Soviet system, Science and Technology (S&T) was, like the rest of the economy, highly fragmented in the way that it was vertically managed from Moscow, mainly through Academies of Sciences, with little horizontal spillovers or co-operation. All three countries have strong research traditions dating back to old and distinguished universities, but they were aligned to the Soviet system and thus over time lost their initial strengths. The research complexes in the countries are large, but were in the

USSR geared towards all-Union aims, particularly military needs and have become over time outdated (World Bank 1992a, 1992b, 1993). Radošević (2003), in his assessment of the post-Soviet Russian S&T sector finds that despite government policies aimed at reforming the sector, general instability, lack of funds and uncertainty often lead to patterns of preserving the status quo, while in everyday life, survival in the face of these problems, dictates the immediate agenda.

The European Commission's Cluster Observatory (EC 2007) identifies some sort of clustering in each Baltic State. It cites the development of furniture, fishing, and oil and gas clusters in Estonia, education, furniture, and fishing clusters in Latvia, and construction, food, apparel, and furniture clusters in Lithuania. However, the methodology of this survey is not entirely applicable to the present study, as it identifies clusters by NUTS-2 regions and four-digit NACE, which are in danger of identifying mere industries in the small Baltic States as clusters. With respect to national weaknesses, the Cluster Observatory confirms many of the findings of the World Competitiveness Reports, and urges for greater co-ordination of the innovative foundations within the countries, i.e. technological readiness, absorptive capacities, and channels of knowledge transfer, among other things.

Estonia's telecommunication cluster dates back as far as 1907, when telephones were first produced in the country. Throughout the 20th century and even in Soviet times, it retained its relatively strong position in this sector (Högselius 2002), but while its ICT sector is one of the fastest-growing in the region since independence, the cluster is still not really focused on innovation but on production (Sölvell and Porter 2004). Ukrainski and Varblane (2006) come to a similar conclusion with respect to the Estonian forest and wood cluster.

In Latvia, one of the major hindrances to the development of a fully-functioning NIS is a lack of coordinating and longer-term policies to develop technology intensive sectors over labour intensive ones, as well as a general lack of funding opportunities for domestic firms (Watkins and Agapitova 2004). The European Commission (2005a) however, comments positively on the Latvian government's newer innovation policies, which have the potential of mending some of the weaknesses. Unfortunately, the National Programme for Innovation was started only in 2003, towards the very end of the time period under analysis in this study.

Lithuania's NIS is still underdeveloped, despite showing the potential for development. The EC's (2005b) appraisal of the country's efforts to build an innovation-driven economy highlights a lack of funding, R&D investment, and coordination as the main weaknesses that need to be addressed. In summary, it seems that Lithuania has simply not come quite far enough in its effort to reform its S&T sector to meet western standards of organisation. It is under threat of losing its initial, rather favourable position as a country with some research tradition to other transition countries that put more effort into the restructuring of their S&T systems.

Radošević (1999a) emphasises that it is particularly the host economies' efforts to learn and master sophisticated processes which can prevent the countries from being marginalised in the world economy. Must (2006) finds that in some sectors, like computer sciences and biomedicine, at least researchers from Estonia and Latvia seem to have been able to bridge that gap in innovative capacity, partly through increased international research collaboration, which at least in academic research seems to have helped to maintain and partly transform science in CEE (Braun and Glänzel 1996) and created some, if weak, assets to be exploited at a later stage.

2.3 Conclusions and Outlook

This chapter has contrasted the strong similarities between the three Baltic States Estonia, Latvia, and Lithuania that derive very much from their shared history and similar natural endowments, and on the other hand the differences caused by different policies and linkages to third countries.

It has become obvious that the Baltic States are rather unique with respect to the length of time over which they almost shared the same fate – starting as early as the mid-19th century with the annexation through the Russian empire and not quite ending with their simultaneous accession of the EU and NATO. Meanwhile, they are not a totally homogenous region, which in itself would make the notion of three distinct nations obsolete. They have distinctly different peoples, with their own cultures, traditions, and above all languages. While similar within the context of a region, they retain their own national character (which is interesting in itself, as nationhood reached them relatively late, compared to others). As such, there are similarities in national mindsets, culture, and history between all the countries around the Baltic Sea, which is the reason that they aim for close co-operation both economically and politically. Yet within the 'cultural cluster' of the Baltic Sea region, the Baltic States form a sub-cluster in itself due to their shared experiences under Soviet rule. Consequently, it will be difficult to find any three countries with such similar starting points of their transition process.

Accordingly, they are very attractive for an investigation indeed and invite comparison, which this study will aim to do. Keeping in mind the differences throughout, it will try to follow the knowledge flows in the region and how they influence the shape of the countries, and it will assess differences and similarities in the Baltic States' development towards market-based, knowledge-driven economies and aim to identify the sources of them. The following two chapters will develop the theoretical and methodological frameworks within which this comparative study is undertaken.

CHAPTER 3

THEORETICAL FOUNDATIONS

3.1 Introduction

This chapter aims to develop a theoretical context in which the beginning of the evolution of the Baltic States from centrally planned Soviet states to knowledge-based economies can be analysed. To achieve this, the theoretical foundations of this development are outlined, while a large body of applied work that explores various aspects of these theoretical approaches in more practical terms is drawn upon to highlight different aspects of the framework.

The analysis of the development of the Baltic States draws on several theoretical approaches. The Investment Development Path (IDP) model and theories of spillovers of knowledge are part of the literature associated with the multinational firm (MNE) (see, for instance, Dunning and Narula 1996). The innovation literature provides perspectives on the development of innovative capabilities through concepts such as absorptive capacity and approaches such as the systems approach. The importance of proximity in stimulating international knowledge flows and transfers of knowledge is highlighted in the literature associated with economic geography.

The IDP approach is particularly useful in the context of the Baltic States, as it focuses both on FDI and the technological abilities of host and source countries of FDI.

As the Baltic States opened their economies to foreign investors rapidly after their independence in the hope of not only attracting capital, but also to 'kick-start' their transformation and the rebuilding of their economies (Ketels and Sölvell 2004), it is reasonable to centre the analysis on a theory that examines FDI as a catalyst for economic development. The second section will therefore explore the IDP model, its applications to various countries, and its adaptation to the Baltic States' context in detail.

In section 3.3, possible spillovers from the MNEs' affiliates to the local economy are discussed. With the focus of this study resting on knowledge flows, the diffusion of knowledge is conceptualised – under which circumstances are knowledge spillovers facilitated and through what channels is technological knowledge transferred to domestic firms and institutions?

Furthermore, the flows of FDI and indeed knowledge in the early stages of transformation from the Baltic region's immediate neighbours have been significant. It is therefore hypothesized that proximity, both geographic and cultural, has a strong impact on these flows. Hence, the influence of proximity on investment, knowledge flows, and the formation of linkages is further explored in section 3.4 of the chapter.

Section 3.5 deals primarily with what happens within the Baltic host economies, once capital and knowledge have been transferred. Taking a systems approach and focusing on the actual knowledge flows into and particularly within the host country, it examines the prerequisites for absorbing and utilising the knowledge.

The focus of the following section is the possible emergence of an innovation system or at least robust networks of sorts that can take the initial impetus of investment and knowledge inflows further and sustain it in order to develop innovative capabilities of their own.

A final section summarises the theoretical foundations of this particular study. It also outlines the contributions made to the existing knowledge concerning the development of innovative capacity, both theoretical and applied.

3.2 The Investment Development Path (IDP)

3.2.1 Theory

The Investment Development Path (IDP) derives from Dunning's (1977, 1981, 1988) Eclectic Paradigm of Foreign Direct Investment, which seeks to explain the presence of FDI by integrating several earlier approaches and perspectives. It is the interplay of the three kinds of advantages an MNE can capitalise on that determine both the MNE's decision as well as the host country's position relative to other countries.

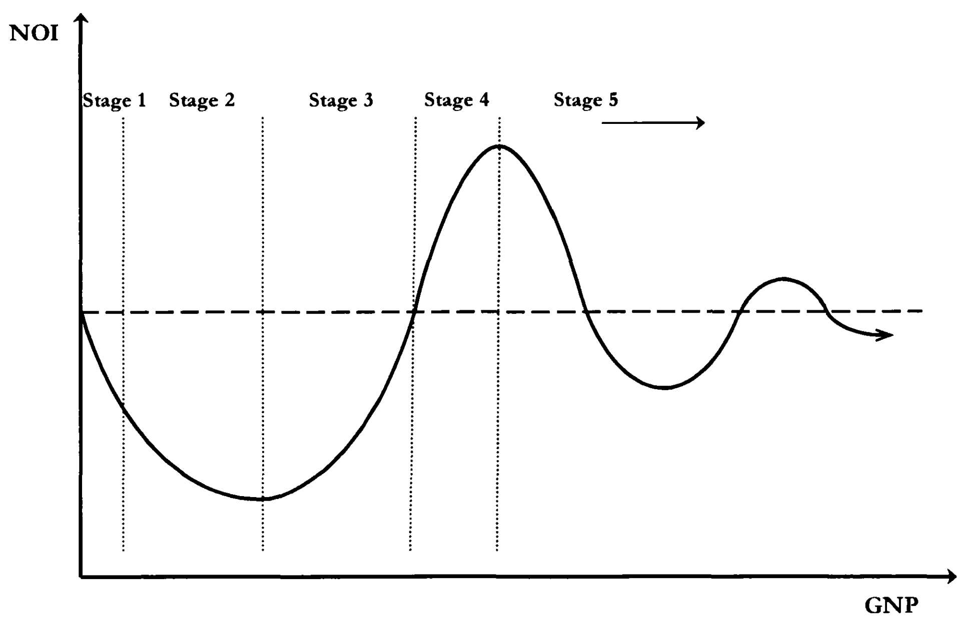
While ownership-specific advantages (or O advantages) refer to the MNE's own competitive edge, and thus describe the source side of FDI, the location-specific advantages (or L advantages) deal with the host side of FDI and thus what makes a country attractive to foreign investors. The internalisation (I) advantage of the paradigm connects the two sides by examining the advantage of hands-on investment and therefore control over the foreign operation over arms-length involvement in the host country. O advantages include, among other things, technology or a brand reputation that are proprietary to the MNE and not or not easily transferable without losing the competitive advantage. A host country's L advantages act as 'pull' factors for the MNE and can include as diverse characteristics as an attractive market, skilled labour or political and legal stability. However, in many cases, to keep the source of the original competitive edge under tight control (or because it is not transferable) and perceived imperfections (or a lack of knowledge about these) of the host environment, FDI as the form of foreign involvement is seen as superior to other forms of entering the host country – the Internalisation or I advantage.

The Investment Development Path theory describes how a host country of FDI evolves along a trajectory, which over time changes the interplay of the OLI factors and with that the investment position of any country; the central hypothesis is that

> ...the outward and inward direct investment position of a country is systematically related to its economic development (Dunning and Narula 1996, p 1).

The IDP and a country's movement along it are defined in five broad stages, which are based on the development of the country's net outward investment position (NOI), as shown in Figure 3.1. The NOI is the difference between total inward and total outward investment in the country in question, thus capturing its position as a net host for or net source of FDI, relative to the outside world.

Figure 3.1: The NOI pattern along the IDP



(Source: adapted from Dunning and Narula 1996, p 2)

Dunning (2001) and Dunning and Narula (1996) define the first stage as one of pre-industrialisation in which a country has almost no inbound and practically no outbound investment, as O advantages of the host country barely exist. International links are established through trade, but as there are hardly any created assets (technological or skills-related) to draw on in the potential host country, foreign firms will be reluctant to become involved more deeply. Any inflows of FDI will be directed at natural resources or labour-intensive manufacturing, but these will be almost negligible, as the host country has no other strengths than its natural endowments with respect to L advantages.

Once L advantages are being built up through government policies, whether they are infrastructure projects or the introduction of investment-friendly measures, the country slowly moves into the second stage. In the context of this study, this is the most interesting point as it is primarily concerned with *how* development is facilitated.

Inward investment is now mainly directed at resource-based sectors, labour-intensive manufacturing, trade and distribution, transport and communication, construction and maybe tourism. This depends on the country's endowment with natural resources, its government policies, the organisation of activity, and the strategy of the (prospective) investing firms. However, inward investment still outweighs outward investment, so that the NOI of the host country remains negative, although, depending on the government's strategy, its worsening will gradually slow down.

The third stage is characterised by the host country's gradual building of competencies and specialisations. There is an increasing stock of created assets in the economy aided by expenditure on education, vocational training and innovative activities. In this stage, as the country moves from purely receiving FDI to the manufacturing of standardised goods, it increases, bit by bit, its outward investment. However, inward investment remains strong, but it is now more directed at efficiency gains, rather than pure, absolute cost saving. Domestic firms develop their own O advantages as they compete for and with the know-how transferred to the country by MNEs (Dunning and Narula 1996). They are able to draw on their own stock of knowledge, partly derived from earlier investment, partly from historical competencies (Anand and Kogut 1997). This means that domestic firms will eventually look for FDI opportunities as well, improving the country's NOI position over time.

Reaching the fourth stage of the IDP, the country achieves a neutral and then positive NOI, its outward investment outstripping its inward investment. The country has built up a solid base of technological capabilities that enable it to transfer its own technology abroad with domestic firms building up their own O advantages which facilitate FDI. In the fifth stage, the NOI hovers around zero, as the country has achieved a position in development that allows it to both receive FDI and be a source of it, with an overall balance to be reached (Dunning and Narula 1996).

It is the late second and early third stage of the IDP that are of greatest interest in the course of this study, however. How is development facilitated? Lall (1996, p 424) argues that while each country evolves over time along the lines suggested by the IDP, the differences between countries may remain large due to structural shifts in countries which are not uniform. He makes the interesting assertion that 'small, resource-poor and outward oriented countries experienced the fastest rate of structural transformation.' Dunning and Narula (1996, p 11) agree with Lall when they state that 'the shape and position of the IDP probably varies much more between individual countries than was originally thought'. They isolate three factors which determine the IDP position of countries: the type of FDI, the structure of the indigenous resources and their capabilities, and the macro-economic and organisational policies pursued by government. These differences between individual countries' movement along the IDP lead Lall to argue that the IPD might be better measured by the transfer of intangible assets instead of only 'hard' investment. This is partly because, while the IDP assumes that FDI inflows may facilitate development by transferring more than just capital to the host country, it does not explain explicitly how this transfer is facilitated. This is discussed in more detail later in the chapter.

3.2.2 Adaptations and Applications

The IDP has been applied empirically to a considerable number of developed, developing, and transition economies, some of which are particularly relevant for this research. Both adaptations/ enhancements of the original theory and empirical applications are discussed in this section.

To come back to the crucial second (and early third stage) of the IDP: Although Cantwell (1992) argues that successful MNEs usually combine more than one reason for internationalisation, and that the growth of the whole firm depends on activities that enhance the firm's knowledge base, in this stage of the IDP the host country will only attract certain, either input or market oriented investment, no matter what additional O advantages the MNE might be able to draw upon.

In their study of the effects of FDI on employment generation in central Europe, Radošević, Varblane, and Mickievicz (2003) redefine this second (or first FDI-involving) stage for CEE in particular by stating that FDI is primarily aimed at capturing market shares for using the host country as a cheap location for the MNE's production processes. First-mover advantages play a vital role in this stage to develop competitive advantages and get 'settled' in the host economy (Lankes and Venables 1996). Especially in the relatively small economies of the Baltic States, the capturing of domestic market shares as a basis for later export-oriented manufacturing seems important. In the adapted model that Radošević et al. present, FDI will develop from being mainly distribution-oriented and/ or of the low value-added kind initially to more efficiency-seeking and later deeply integrated, export-oriented. Bos and van de Laar

(2004)[3] however fail to find any evidence that FDI inflows into Central and Eastern Europe from the Netherlands is induced by the 'need' of transformation economies to catch up with more highly industrialised countries, so there is no need to adapt the IDP. They argue that the determinants of FDI into CEE can be found mostly in fundamental economic theory, rather than in any 'special' situation CEE finds itself in, namely a radical restructuring of the domestic economy in connection with high instability and uncertainty. Meyer (2002), in contrast to Radošević, Varblane, and Mickievicz, elaborates about possible 'late-mover advantages' that are particularly strong with regard to transition economies (first movers having paved the way for late-movers). Still, to be able to master the difficulties that the specific situation in the Baltic States poses, it seems obvious that those with a certain 'feel' for the countries are more likely to succeed. However, it is possible that the closer Nordic countries have been paving the way for the latecomers, particularly the traditionally strong foreign investors: mainly Britain, Germany, and the US – while the latter is geographically distant, it has close cultural links with both Latvia and Lithuania.

Gorynia, Nowak, and Wolniak (2007) support that opinion in their study of Poland's development along the IDP. They find that the model poses several challenges to the situation of developing countries in general and transition economies in particular. Using the NOI to determine the stage a country finds itself in is not sufficient in itself, as for instance the first and fifth stage are characterised by similar, if not the same, NOI positions. Thus, in line with Lall (1996), they argue for complementary measures to asses a country's position, like its position along what they and Ozawa (1996) term the technology development path (TDP), i.e. the country's position as a receiver or emitter of technology. Furthermore, the domestic economy in relation to the 'outside' world needs attention, as this can distort the 'pull' and 'push' factor balance that the original

[3] The authors do not examine the IDP, however, but use a gravity model.

IDP assumes. While Poland's IDP position is behind what might be theoretically justified by its GDP because of its large internal market, the Baltic States are small markets – which, however, are relatively large compared to those of the (themselves small) major source countries of FDI that are close by. The importance of a large internal market as a restriction of the theorised IDP is caused by the fact that it increases a country's absorptive capacity for FDI and trade. While Poland's GDP per capita has grown enough to justify a more advanced NOI position, its economy can absorb much more inward investment, even if outward investment is growing. Thus, its actual NOI position 'lags' behind what would be expected in theory.

In his analysis of home country patterns of FDI in Central and Eastern Europe, Hunya (2000) describes several factors that induce investment in transition economies: Cultural proximity, a sufficiently large emigrant population, historical links, and geopolitical interests. He emphasises that first-mover advantages can only be realised by firms that have, because of their origin, certain market knowledge or can gain it with little effort. It can thus be argued that all the major source countries of FDI (and knowledge flows) into the Baltic States have at least one of these characteristics. The Nordic countries belong roughly to the same cultural cluster as the Baltics – especially Finland and Estonia, but also the Baltic Sea region in a wider sense is found by Hofstede (2001) to exhibit roughly the same cultural characteristics. Hofstede, in his landmark study of IBM employees throughout the world, found the Nordic countries to form a loose cultural cluster, with similar scores in the four dimensions of culture he used to classify attitudes.[4] While the Baltic States were not included in his study, he found that generally countries close to each other share attitudes. On the other hand, both the US and

[4] The four dimensions of the study are (a) power distance (the degree to which authority is accepted), (b) individualism vs. collectivism, (c) masculinity vs. femininity, and (d) uncertainty avoidance. In a later update of the study, he adds a fifth dimension, long-term vs. short-term orientation of society (Hofstede 2001).

Germany have a relatively large population of expatriates from the Baltic rim, some of whom have been returning since independence. All of the source countries arguably have some geopolitical interest in the area, having strongly encouraged and assisted the Baltic States' integration with the Western world after their independence.

To shed light on the development that takes place in this second stage, Dunning (2001, p 181) says about this stage of the IDP that

> gradually it [FDI], and any investment by indigenous firms, will affect both supply and demand conditions for the products supplied by foreign firms and their desire to internalise their markets for the competitive advantages.

Lall and Narula (2006) invoke the picture of a 'virtuous circle': they argue that FDI into knowledge-intensive industries is what they call 'location-sticky', building on a base of already existing knowledge that is location-specific, enabling the host country to create its own assets out of its existing setup and an upgrading through FDI. Finding the right, possibly technologically or at least culturally close environment, MNEs find it easier to tap into local capacities, and from there interact with this environment by sequentially updating their own and the host economy's capabilities. With the Baltic States providing relatively high-skilled labour and a modest research tradition, MNEs from close-by countries as the Nordics may find the 'seeding-ground' for their own expansion.

Ozawa's (1996) analysis of Japan's industrialisation process adds to the notion of a win-win situation. He distinguishes between consumer and producer goods, adding more depth to the IDP model. While a consumer product industry develops first through inward, cost-reduction-seeking investment, the host country accumulates enough specific knowledge over time to develop a corresponding producer goods industry – this happens mainly through imitation, but can be fostered by domestic competition. He also distinguishes between the host economy as a whole and particular sectors that receive more FDI that others; something that corresponds with Anand's and Kogut's (1997) finding that it is R&D-intensive sectors that interact more strongly internationally – the host country has the possibility to attract FDI to existing, 'strong' sectors and reinforce this specialisation by upgrading its own facilities through precisely this FDI. Two kinds of knowledge spillovers are combined in Ozawa's view, both imitation (i.e. genuine learning) and complementation (i.e. upgrading) play a role in his view of the IDP.

As Barry, Görg and McDowell (2003) show in their study of Ireland's movement along the IDP that, although inward investment is mainly flowing into high technology sectors, the country's outward FDI does not. They trace FDI flows in and out of Ireland, broken down into sectors. While Ireland has received considerable FDI in high technology fields like information technology, it does not seem that its outward investment happens in the same sectors – its NOI is skewed and varies over sectors. This suggests that, while the IDP is valid with respect to total FDI, it is not necessarily sectors that receive investment that turn into the strongest of the economy in question. Bellak (2001) adds to this that not only do sectors differ in their movement along the IDP, but finds in his study of the Austrian IDP that it is also different source countries that form 'bilateral' IDPs with the host country Thus, the host country's overall IDP position can differ significantly from its bilateral ones with selected source countries.

Following these considerations it could be argued that, while within the country, in this case the Baltics, the knowledge stock has been built up through direct and indirect spillovers from MNE activities and has thus created new O advantages, the L advantages that pulled FDI in initially have changed as well. With infrastructure (both physical and in knowledge) improved through corporate and government activity, more high-technology investment is now pulled into the country. This would mirror partly the much older life cycle and technology gap assumptions of Vernon (1971) and Posner

(1961), who both emphasised the changing interplay between the source and host countries' levels of technological development in their explanation of trade flows.

Accordingly, Dunning, Kim, and Lin (2001) incorporate trade into the IDP, linking what they call the Trade Development Path with the original IDP. Separating traded goods into categories of above average, average, and below average FDI-intensive goods, they show in their study of the IDP and Trade Development Path for Taiwan and South Korea that traditional theories on internationalisation hold true. The NOI lags behind the trade position of the countries, but the IDP overall follows the trade development path, confirming that trade is the 'easier' way to internationalise and that it paves the way for subsequent investment. Furthermore, for above average and average FDI-intensive goods, FDI partly replaces trade at later stages of development.

Out of these newly acquired O advantages or created assets, firms from the original source country are now able to expand with standardised goods (both in trade and, more importantly, FDI), while inward FDI growth levels off to some extent, reflecting the presence of an inward FDI stock that is expanded, rather than 'new' FDI from scratch.

In their study of Poland's development along the IDP, Gorynia, Nowak and Wolniak (2007) locate the Baltic States at precisely this border between the second and third stage, i.e. the emergence of O advantages, with Estonia slightly ahead of the two other countries. However, Brouthers, Brouthers and Werner (2001) report that not only are countries in CEE not particularly attractive for western R&D investment; but when MNEs do invest in foreign R&D facilities there, they prefer wholly owned, not deeply embedded subsidiaries, partly due to turbulent economies and 'low trust cultures' (Brouthers, Brouthers, and Werner 2001, p 84). However, it is possible that the Baltic States can overcome these general weaknesses associated with their position as transition economies through their proximity – geographic, historic, and cultural – with their main sources of FDI. Therefore, a closer look at the importance of the concept of proximity is taken below, after the already mentioned spillovers as catalysts of development are discussed in more detail.

3.3 Spillovers

The assumption that knowledge is transferred as one part of the 'bundle' of benefits that are connected with FDI is central to this study. While this section briefly reviews the concept of spillovers itself, the factors that induce or influence spillovers is explored in much more detail in the following sections, thus coming back to the concept.

It is assumed that knowledge spillovers are a consequence of a foreign affiliate implementing new technologies and organisational skills that usually are superior to those of domestic firms (Damijan et al. 2003). In their analysis of MNEs' locational decisions in European regions, Cantwell and Piscitello (2002) find that is indeed the potential market and the possibility of intra- and inter-industry spillovers in the host country that attracts R&D activities of MNEs.

Markusen and Venables (1999) examine the effect that the entry of an MNE has on the domestic economy. They find two major forces, (1) a competition effect, e.g. the substitution of the MNE's goods for those of domestic producers, and (2) a linkage effect that is mainly working within the business network, introducing new techniques and technologies to suppliers and/ or customers. Both effects can be extremely valuable in explaining the effect FDI and spillovers of knowledge have on the development of the host economy. The MNE's O advantage can be levelled and transferred to indigenous firms through those two effects and thus foster development.[5]

Sinani and Meyer (2004) find support for those two patterns in their study of spillovers in Estonia using a firm-level panel data analysis to establish how FDI affects the output growth of Estonian firms. They find that spillovers occur mostly in industries that have received substantial FDI and depend on firm size, ownership structure of the indigenous firms, domestic firm trade orientation and their proximity to foreign firms. Vahter (2005), in a similar panel data analysis, finds relatively few technology spillovers from inward FDI, with those few being greater for firms that are oriented towards their own home market. Cheung and Lin (2004) find that FDI in China has indeed demonstration effects that encourage domestic patent applications in its wake. Driffield and Hughes (2003) support this insofar, as they, studying the effects of FDI in British regions, find that FDI mostly contributes to the host region's development – if the technology gap between source and host country is not too big.

Focusing on knowledge flows and thus deviating from the original IDP in the way Lall (1996) envisaged, two patterns of innovation have been described by Breschi, Malerba, and Orsenigo (2000), and Lundvall et al. (2002): these can be traced back as far as Schumpeter. Following Schumpeter (1942), the process of diffusion of knowledge can be mainly seen through either imitation or active competition, e.g. the attempt to compete through the introduction of their own, even better products or processes of domestic firms:

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5 Of course, competition effects can be both positive or negative on domestic firms – while they might lead to upgrading, competition might also drive uncompetitive businesses out of the industry, particularly if the technology gap (which is discussed further below) is too great. Usually both effects take place to some extent.

- A Schumpeter Mark I pattern shows the process of 'creative destruction', where a fundamental role is played by entrepreneurs and new firms that continuously threaten the position of incumbents.
- A Schumpeter Mark II pattern instead is characterised by 'creative accumulation', where incumbent firms build on their own experience and knowledge to generate innovations and by that ownership-specific advantages.

Within these patterns, three defining dimensions can be identified: (1) the rate of concentration of innovative activities among firms; (2) the degree of stability in the hierarchy of innovative firms; and (3) technological entry and exit, i.e. the relevance of innovators at all (Breschi, Malerba, and Orsenigo 2000). These dimensions will take on greater importance when the forming of innovation systems will be discussed later on.

A Schumpeter Mark I pattern could take two shapes in a transition economy. One would assume that the investing MNE acts as the entrepreneur in the new environment, breaking up inherited patterns of production that have been implemented under a Socialist, centrally planned regime. This would threaten incumbents like state monopolies. On the other hand, once the competition effect Markusen and Venables (1999) describe is taken into account, demonstration and imitation within the host economy could lead to a more vigorous competition first in the host country and later on, when domestic firms build their own expertise and knowledge stock (and thus their own O advantages), lead those domestic firms to investing abroad themselves. The indigenous firms then become the 'entrepreneurs'.

The Schumpeter Mark II pattern seems to be less important with respect to the catching up process of the Baltic States – however, assuming that a firm's knowledge stock also comprises 'location-specific' knowledge, the linkage effect would enable domestic incumbents to tap into foreign firms' knowledge and thus help them to accumulate and enhance their own stock of relevant knowledge. Their knowledge of the specific environment would in turn be beneficial to the MNE, making co-operation through e.g. strategic alliances a win-win situation. However, Breschi, Malerba and Orsenigo (2000) claim that innovative patterns depend largely on the technological and not the cultural framework.

Radošević (1999b) finds that it is indeed foreign firms that are currently taking the lead in re-shaping the innovative environment in transition economies towards a knowledge-based economy, rather than the governments of these countries, so it is reasonable to combine MNE presence in the Baltic States with a more general view on innovative activities by all possible actors in the region. However, Bosco (2001) finds no such evidence for FDI in Hungary, reporting that spillovers hardly happen between the generally more innovative MNE affiliate and the surrounding domestic firms, and that FDI in high-technology sectors does not aid the development of the sector.

However, it must be emphasised that while R&D co-operation takes a key role in the transfer of knowledge and technology, reducing the analysis to only this transfer channel would limit the understanding of the phenomenon severely. As will be discussed in more detail later, alliances of all kinds between firms are playing an important role as well. As Lorentzen and Barnes (2006) note in their study of the South African car industry, know-how diffuses in many different ways and is hardly unidirectional – through imitation, learning-by-doing, etc, and inventions do not necessarily always stem from R&D activity within firms. Thus, this study looks at other channels of transmission that are more indirectly measured, but capture a wider range of possible spillovers.

Sorenson, Rivkin, and Fleming (2004) add to this that effective transfer depends on the quality of the knowledge involved and find that knowledge of 'medium complexity' is most easily transferred, and that the interplay between social networks, technological capability, and geographic proximity determines the ease of the transfer.

3.4 Proximity

A central hypothesis of this study is that knowledge, as well as investment, is most easily transferred if the source and the receiver are either geographically or technologically close. This rests partly on the assumptions first postulated in the gravity theory of trade and FDI, which assumes that there is a positive relationship between the economic 'weight' of countries and the trade flows between them, and a negative one between the distance between the countries and trade (Ghemawat 2001). While gravity theory deals predominantly with the similarity of countries (which could be seen as 'proximity'), the concept of distance takes on different guises: For instance Helliwell (1998) promotes the measure of remoteness, rather than distance, by combining the size of a targeted market (income as well as absolute size of the population) with geographical distance. He argues that the conceptual distance between source and host country increases not only with geographical distance itself, but also with decreasing size of the host country. In this sense, the Baltic States qualify as 'remote' from most Western investing countries, but not from the relatively small and close-by Nordic countries, which would experience greater 'gravity' towards the Baltics than most other countries. This is upheld by Bellak, Leibrecht, and Riedl (2008), who find that distance, when understood as a cost factor, acts as a deterrent to FDI in CEE.

Distance, in the view of management theory in particular (Ghemawat 2001), consists of four dimensions, which all affect the ease with which a firm can internationalise its activities through trade and FDI vis-à-vis other countries; these are reported in Table 3.1 below:

Table 3.1: The CAGE Framework of Distance

Distance			
Cultural	*Administrative*	*Geographic*	*Economic*
different languages	absence of colonial ties	physical remoteness	differences in consumer incomes
different ethnicities	absence of shared monetary or political ties	weak transportation or communication links	differences in cost and quality of:
lack of connective ethnic or social networks	political hostility	lack of sea or river access	natural resources
different religions	government policies	lack of a common border	financial resources
different social norms	institutional weakness	differences in climates	human resources
			infrastructure
			information or knowledge
			intermediate inputs

(Source: adapted from Ghemawat 2001, p 140)

These four dimensions, *c*ultural, *a*dministrative, *g*eographic, and *e*conomic (CAGE) distance constitute what amounts to a 'lack of gravity', i.e. where gravity describes similarity between countries, distance captures dissimilarity. It seems safe to assume that geographic and cultural distance is lowest between Baltic and Nordic countries (with the exception of social norms due to Soviet rule in the Baltics), while administrative and economic differences certainly constitute dissimilarity. This follows partly from Hofstede's (2001) findings, which placed the Nordics in one cultural cluster – with the Baltics sharing the location as well as many historical links with them. When considering that the Nordic as well as the Baltic countries are comparatively small with (especially in the Nordic countries) only a relatively small number of large MNEs, it is possible that cultural and geographic proximity encourages SMEs from the Nordic source countries to seek hands-on involvement in the Baltic economies. Indeed, Ghauri and Holstius (1996) find that all Nordic governments had taken steps to formally promote business interaction between their own and the Baltic States quite early in the transition process. Taking a network perspective, they show through case studies that step-by-step integration is taking place on all levels of economic activity around the Baltic Sea.

However, distance can also be caused by different stages of development that host and source country find themselves in, and a convergence of sorts, mainly by growth of the less developed (transition) country, would lead to the closing of this gap. This is a kind of 'temporal' distance, which manifests itself in those different stages of development and decreases with the catching up of the lesser developed country. Freeman (2002) introduces the concept of countries 'forging ahead' or 'catching up' in the process of globalisation. Cultural and geographical proximity between countries influences the rate of this catching up process through technology transfer and spillovers, in turn induced through FDI, which in this context would imply that the geographical closeness between the Baltic States and their main investors from Scandinavia influences the rate and direction of the Baltics' development considerably. Markusen and Venables (1995) support this notion by introducing what they call the 'convergence hypothesis': Countries that interact with each other, first through trade and later through FDI ties, become increasingly similar to each other in 'size' or rather there is a reduction in the distance between them, i.e. in relative factor endowments and technological capabilities. The shift towards FDI, rather than trade, happens when the proximity has grown to a degree where MNEs find it advantageous to internalise their operations. This of course does not mean that FDI replaces trade links entirely. As the incorporation of trade into the IDP (Dunning, Kim and Lin 2001) and other studies (Bos and van de Laar 2004) show, the two are often complementary and there is rather a shift from inter- to intra-industry trade, rather than a reduction, that accompanies FDI. However, Pan (2003) reports that geographic proximity has no positive influence on FDI in his analysis of determinants of FDI in China. Given the size of the Chinese economy, it is possible that different factors would encourage FDI in the much smaller Baltic States.

Cultural proximity (e.g. through historic links), on the other hand, minimises the need to adapt products/ processes to the 'new' environment, as this cultural proximity can also be seen as a closeness of tastes and attitudes. Krugman (1991) states that the location of economic activity is greatly influenced by what he calls 'historic contingency', i.e. social, cultural, and political forces.

Turning to the concept of the loose cultural cluster that the Nordic and Baltic countries form, Kogut and Singh (1988) provide evidence that the entry mode depends, among other factors, on the cultural distance (or proximity) between host and source country of FDI. They study FDI in the US and find that greater proximity raises the likelihood of acquisition as the chosen entry mode, as different management styles are less likely to cause difficulties. This explains to some extent the dominance of Nordic investors in the privatisation processes in the Baltic States.

Further support for the importance of cultural similarities is provided by the Scandinavian School of internationalisation, which argues that firms will internationalise incrementally, i.e. first in economies that are culturally close to them to develop a feel for operating in foreign environments (Barkema, Bell and Pennings 1996). This incremental approach is roughly in line with the stages of the IDP, although it provides a slightly different perspective. When the model is applied to SMEs' activities, it follows that SMEs will often only internationalise in such a narrow way, staying nearby culturally and geographically. Rugman and Verbeke (2004) confirm this when reporting that MNEs' strategies often involve the exploitation of similarities between markets in one and the same region.

In their study of foreign market entry decisions by 19 MNEs, Mitra and Golder (2002) find that near-market knowledge, both cultural and economic, increases the likelihood of entry. Larimo (2003) analyses the form of entry Nordic MNEs choose in foreign markets and finds several similarities. Whereas Swedish multinationals tend to focus more on host country characteristics, Norwegian and Finnish firms consider both their own home and the host country's features. Overall, Nordic firms seem to prefer acquisition as the mode of entry, which in turn the author finds to be related to cultural distance and a higher R&D intensity of the industry. While cultural distance, a high R&D intensity, and high economic growth of the target country all increase the probability of Greenfield investments, this seems to hold true for the case of countries around the Baltic Sea: Nordic firms not only have participated in privatisation projects, they have also established lesser-embedded production and distribution facilities. Nakos and Brouthers (2002) support this when they look at the entry mode that SMEs choose in CEE more generally. Dunning and Lundan (1998) demonstrate that, among other factors, the MNE's size is inversely related to its need to protect competitive advantages through their activities abroad. In their study of a Fortune 500 survey as to how firms derive some of their competitive edge abroad, they show that while the largest firms rely most heavily on their home base, smaller firms from high-wage, high-technology economies are more likely to source their knowledge in their foreign activities. This would explain the interest that Nordic MNEs have in the Baltic States: relatively small MNEs from small, open, and knowledge-based economies that try to source at least part of their competitiveness in countries that 'match' them while at the same time opening up new markets.[6]

Turning to the issue of spillovers between the MNE subsidiary and domestic firms in the host economy, it is again distance, or rather proximity, which acts as a catalyst for them. Despite explicit or codified knowledge being technically readily availably to everyone, its diffusion usually follows a physical path, spreading from its source first to close-by firms, for instance in the form of traded goods or the mobility of employees (Matusik and Hill 1998). In their pioneering study of geographic knowledge diffusion through patent citations in the US, Jaffe, Trajtenberg, and Henderson (1993) find that

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[6] Of course the Baltic States would not match the Nordic countries initially in terms of technology, but rather be attractive because of their inherent proximity, i.e. the possibility of developing 'towards' the Nordics quite easily.

initial spillovers are highly localised, with domestic patents being mainly cited by other domestic inventors. Using simple patent counts for European regions, Bottazzi and Peri (2003) arrive at the same conclusion.

Co (2002) adds some interesting evidence to these findings. Using both absolute patent counts and the technological specialisation of patenting activities, she examines the catching up process of US states compared to high-technology states. She finds evidence for knowledge diffusion through clusters and the importance of geographical proximity for this process of catching up. These findings are confirmed by Sonn and Storper (2003), who use patent citations to arrive at roughly the same conclusions as Co. Coccia (2008) finds in a study of technology transfer within Italy that the combination of geographical and technological proximity influence the rate of transfer strongly and that, while geographical distance makes technology transfer much harder, it is the geographic clustering of related industrial activity that enhances absorptive capacities of firms on the other hand. That knowledge is most easily passed on between firms in geographically tightly-knit clusters is confirmed by Halpern (2007) in his study of FDI in Hungary. He finds that horizontal spillovers (i.e. spillovers at the same stage of production) between MNEs and domestic firms are strongest when the distance between the firms is lowest. Piga and Poyago-Theotoky (2005) support and broaden this view by reporting that spillovers are indeed greatest where firms are close to each other. This forces firms to distance themselves from their competitors when products become more differentiated in order to limit unwanted spillovers. This is, however, unlikely in the case of the Baltic host economies, where the innovative capacity of domestic firms needs to be developed first in order to compete internationally.

Using a patent database, Guellec and van Pottelsberghe de la Potterie (2001) find the internationalisation of technology to be increasing across OECD countries. They define the internationalisation of technology at a high level of generality to mean that inventions cross international boundaries more frequently along with the ownership of inventions and the people generating them. They confirm some findings reported earlier: that small countries have a stronger propensity to internationalise their technology, as well as countries with a lower technological density, and that geographic proximity is central to successful knowledge diffusion. Furthermore, that technological proximity enhances cross-border collaboration, and that specifically the Nordic countries are very likely to collaborate internationally.

Turning to the technological dimension of proximity, Lee (2006) finds evidence that knowledge is transferred most easily between countries that are technologically close to each other (i.e. where the technology gap is not too large) and that are linked through FDI, rather than trade. However, this attraction is mutual to some degree, as it is the ease with which technology transfer happens in the host country that seems to induce FDI in the first place, as Grünfeld (2006) finds. The expectation of localised knowledge spillovers (in both directions) influences firms' decisions to go multinational in the first place – i.e. they look for a technologically close environment, as they expect to benefit from a more fertile environment. Furthering this analysis, Fung and Chao (2002) find that also a significant part of spillovers, 19%, happens within an industry and is further facilitated by technological proximity between the source and receiver. On the other hand, the targeted market should not be too close, as this would create stronger competition for the MNE – the aim is to tap into the local pool of generic knowledge and skills, without facing strong competition by investing in a sector where the host country already has a competitive edge internationally (Grünfeld 2006).

Taking the 'opposite' perspective of the firms receiving this inflow of knowledge, Nieto and Quevedo (2005), in a study of the absorptive capacity of Spanish firms, develop a measure for the ability to benefit from other firms' innovative effort and make use of spillovers. They construct their variable with the level of communication with the environment, the firm's own technological level, the diversity of the knowledge structure and the firm's strategic position within the industry, finding that it is this firm-specific variable that has the strongest influence on whether the firm can utilise the innovations made by others. This supports the notion of embeddedness and that there must be some 'understanding' or closeness between the knowledge source and its potential receiver. The Baltic States, with their reasonably well-educated workforce and quite a strong university and/ or Academy of Science sector, seem to provide the pool of generic skills without overly strong incumbents that could compete vigorously with the MNE.

A disadvantage of proximity is uncovered in the study Javorcik, Saggi and Spatareanu (2004) conduct on FDI in Romania. They find that spillovers increase with the geographical distance between the source country and Romania and attribute this to MNEs from farther away having to source more locally.

With proximity (of all four kinds) being crucial for the attraction of FDI and its subsequent 'success' of transferring technology and more generally knowledge to the host economy, the next step is to examine how these inflows can be utilised inside the host country and aid the development of domestic innovative capacity.

3.5 'Seeding Ground' and Systems

What exactly happens within the Baltic host economy when knowledge from other countries is transferred by MNEs depends largely on the 'seeding ground' it falls on. Geographic proximity is one parameter that helps in explaining the attraction of knowledge, but it is the absorptive capacity of the host countries that determines how much of this knowledge inflow can actually be utilised. It is thus technological proximity that matters most in this context: which type of expertise the firms of the source country 'carry abroad', and what kind of expertise they encounter in the host country.

3.5.1 *Absorptive Capacity*

Cohen and Levinthal (1990, p 128) define absorptive capacity as

> the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends [...].

It is crucial for firms in the host economy to be able to absorb and utilise the technology provided by FDI in order to accumulate a 'critical mass' of knowledge available (Döring and Schnellenbach 2006). Only this will allow the host economy to build its own capabilities from these absorbed influences.

The question concerning whether transition economies like the Baltic States have the capacity to utilise the knowledge they are 'exposed to' by investors from developed countries, or whether the technology gap between the source and recipient economies is too large to bridge, is illustrated by a study by Johnson and Ivenson (1999). They find that most knowledge flows in the form of patents extended from one country to another are strongest between OECD countries, and a lot weaker between OECD countries and newly industrialised countries (even weaker between OECD and less developed countries). These results suggest that not every patent applied for in an industrialised economy would be considered 'worth' patenting in the Baltic States that are not advanced enough yet to enable the proprietor of the patent to fully exploit it there.[7] This may at least partly lie in the fact that the main difficulties transition economies face when it comes to the creation of the 'seeding ground' for innovation systems are: the

[7] While it was argued before that the Baltic States have a skilled workforce and a research culture, research in the Soviet Union was highly disconnected from its actual application. Again, while there seems to be some fertile ground in the countries, it might be too early to build on it.

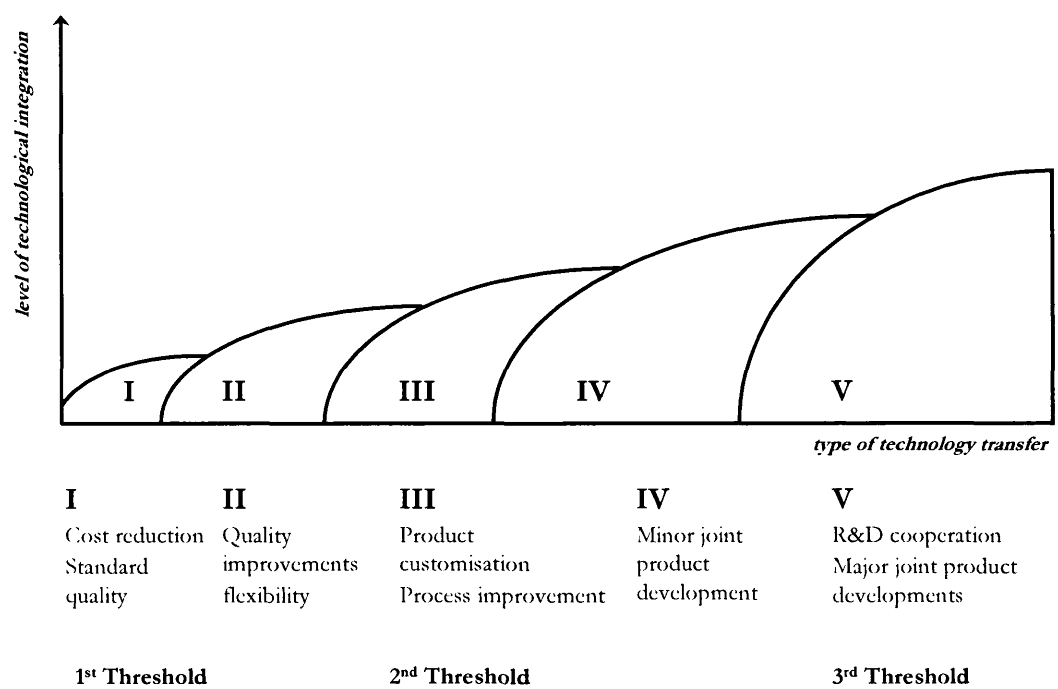
creation of viable institutions that govern the processes, the need for a complete reorganisation of the division of labour and the political and economic uncertainties associated with minor and major shocks of political processes and economic development due to recurring minor and major shocks (Fritsch and Werker 1999).

Radošević (1999a) adds that it is the host economy's own effort to learn and master sophisticated processes that is vital for preventing the country from being marginalised in the world economy. This seems to be happening, at least partly, as Must (2006) reports that in specific sectors, like computer sciences and biomedicine, at least researchers from Estonia and Latvia seem to have been able to bridge that gap in innovative capacity, partly through increased international research collaboration, which at least in academic research seems to have helped to maintain and partly transform science in CEE (Braun and Glänzel 1996) and created some, if weak, assets to be exploited at a later stage.

Anand and Kogut (1997, p 449) emphasise that proprietary assets or ownership advantages are also related to geography. They are a result of the different institutional setting in different countries as well as of 'historical accumulation of capabilities at the firm level'. In their study of investment flows, proxied by reported entries into the host economy (for the US, Britain, and Japan), they find that it is the technological sector that influences FDI between countries – if both countries exhibit strengths in the same or closely related sectors, this will induce investment. In their view, there are advantages that may reside within firms, but are still to some extent location-specific, as they are confined to certain geographical boundaries. As knowledge is 'stored' within people, firms, and networks within a country and is often tacit and an almost public good to all actors involved, it is the boundaries of the country that demarcates this pool of knowledge. Tapping into this pool can be done through FDI by firms that have already a 'feel' for this knowledge, however weak at the beginning, and are thus closer to the targeted host country. This may at least partly explain the Baltics' attractiveness for Nordic investment, as Baltic firms could possibly provide, if not technological prowess, then an ability to adapt rather quickly due to their knowledge of the networks still persisting in some parts of the economy. Cultural proximity would make the forming of possible alliances between host and source country firms much easier.

Radošević (1999a), taking a rather broad definition of alliances, adds to this by assigning an important role to alliances (more or less formal co-operation) between MNEs and domestic firms in transferring knowledge and technology to the transition economy. Learning, however, is not a continuous process, and Radošević identifies different forms of alliances between foreign and domestic firms leading to different kinds of technology transfer, as shown Figure 3.2 below.

Figure 3.2: Kinds of technology transfer, depending on the nature of inter-firm co-operation



(Source: Radošević 1999a, p 46)

In line with Turok's (1993) concept of embeddedness as a catalyst of technology transfer, it is the depth of the alliance that determines how and in which direction technology is transferred, with types III to V involving increasing innovative efforts from the domestic partner as well, while types I and II are mostly or entirely foreign-led co-operations. In a way, this perspective corresponds with the IDP by analysing knowledge flows, their intensity, quality, and direction within a framework of stages. What kind of co-operation is sought does not only depend on the 'seeding ground' the host country provides, but also on the affiliate itself. Depending on the nationality and organisational structure of the MNE, the affiliate can either be knowledge creating itself (thus forging alliances of the types IV or V), or simply exploiting the knowledge provided by the parent (with little or even no interaction in the host environment) (Pearce 1999, Cantwell and Mudambi 2003, Manea, Ghauri, and Pearce 2002). The Baltic States, given their relatively early stage of development, would probably not quite have crossed the 2nd threshold yet.

Turok (1993) examines this issue in his study of how embedded foreign firms are in the Scottish 'Silicon Glen', finding that their decision whether to form links with local firms or other foreign ones depends on several factors, for instance the level of technology, responsiveness of the partner and the quality suppliers can provide. Only if the domestic firms themselves engage in the process of upgrading and are willing to work towards enhancing their own abilities, can the benefits of MNEs' investment be fully utilised (Dyker 1999). This is supported by the finding of Yamin and Otto (2004), who also conclude that local embeddedness enhances the subsidiary's innovative performance among biopharmaceutical MNEs.

3.5.2 Specialisations

It is not always the case that a (source) country excels in the same technological fields at home and internationally. Paci, Sassu, and Usai (1997) find that international and domestic patenting performances vary significantly for the six industrialised countries they examine; they conclude that internationally competitive knowledge is only one aspect of a country's innovative effort. Domestic activities are not necessarily 'poorer' but reflect the fact that domestic markets differ from international ones. Accordingly, Marinova (2001) only reports one part of the broader picture when she analyses US patenting from CEE. Nevertheless, some conclusions can be drawn. The CEECs' patenting performance is roughly in line with their former strengths under central planning on the one hand, and on the other hand it broadly follows other economic trends after the fall of the Iron Curtain. Marinova does not include the Baltic States in her analysis, yet the relatively common patterns and the inclusion of the former USSR allow for the tentative assumption that the countries would follow the paaterns of others.

Cantwell and Kosmopoulou (2003) introduce the distinction of home and host country perspective as well, and argue that the different technological patterns at home and abroad can be explained by different strategies and backgrounds of MNEs: Small home countries, host countries that offer specific skills or their own technology, and activity in very internationalised industries often shift MNEs' activities from 'merely' exporting general strengths of the home country and rather develop an international profile different from the home base. With Nordic MNEs very active in the Baltic States and the host countries emerging from central planning, the technological specialisations of the MNEs may very well leave an imprint in the Baltics' innovative patterns. However, path-dependency seemingly plays its part as well, with national profiles being historically determined and thus varying from relatively late international developments.

With respect to development *within* a country, Breschi, Lissoni, and Malerba (1998), as well as Patel and Pavitt (1997) point out that innovative success is of a mostly accumulative nature, while new areas of innovation are mostly closely related to the original field. In a national context, this would mean that persistence is rewarded more than imitation, as imitation does not build on prior knowledge. This would imply that the Baltic States will have to reach – often through absorption and the preservation of knowledge developed when they were part of the USSR – a 'critical mass' of knowledge that allows them to eventually develop their very own specialisation out of the knowledge accumulated. Jaffe (1989) confirms this in his study of technological opportunity in US clusters, as he finds most opportunities in related, but slightly different fields from the firm's core area of activity. Edler (2003) adds a further dimension to international interdependencies in innovative efforts, noting that US MNEs actively tap into the knowledge base in Germany by forging partnerships with indigenous firms. With Baltic, often academic, expertise in certain areas, this seems a plausible scenario for MNEs in the Baltic countries as well, at least for some MNEs.

With these issues in mind, it seems sensible to follow the development of the knowledge economies of the Baltic States by proxy of their national technological specialisations and their respective evolution, as compared to the specialisations of the major source countries of FDI and technology.

Assuming that at least some knowledge will spill over from foreign subsidiaries to firms in the Baltic States and thus induce development there through pressure to innovate, the question arises what happens next. Following the analogy of the IDP, the Baltic States should develop their innovative capabilities first at home, before they reach the level of sophistication that allows them to 'export' their knowledge abroad. Carpenter and Narin (1983) find that industries vary with respect to their dependence on foreign or academic knowledge in an analysis that uses US patent citations. If a small, open economy gains access to this international knowledge base and can possibly draw from a strong university sector of its own, it might benefit greatly in its own development.

3.5.3 Clustering/ Systems

The innovation literature stresses that the ability of firms to absorb external knowledge and to use and develop their own technological specialisations should be analysed from a 'systems' perspective. A number of concepts are introduced in the literature, which enhance the understanding of the innovation process, but overlap to some extent. Innovation systems, clusters, and networks all point to the interaction of firms with their external environment, with the definition of the environment wider or narrower depending on the concept.

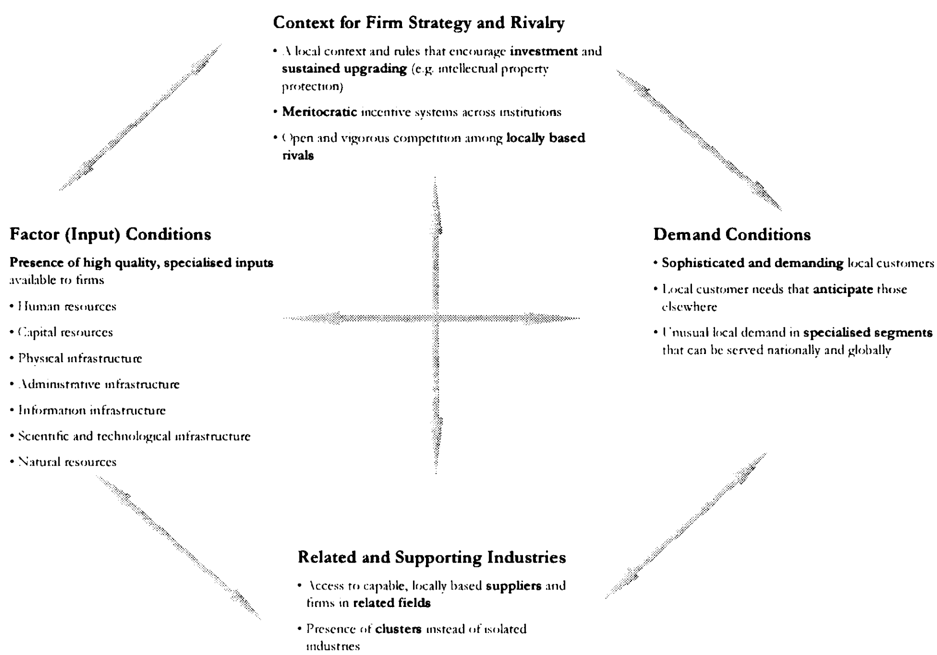
The definition of an innovation system is a rather broad one. It is 'a set of institutions whose interactions determine innovative performance' (Nelson 2000, p 276). Originating as far back as List's (1841) emphasis on intellectual capabilities within an economy (as opposed to purely 'material capital') as a growth factor and over Marshall's (1890) notion of 'knowledge hanging in the air' in industrial districts, it has become an important analytical approach to assess the knowledge creation and accumulation process in a pre-defined economic area (Lundvall 1992, Nelson 1993, Freeman 2002, Lundvall et al. 2002). An area in this context can be a region, a nation, or even an industrial sector. Edquist (2005, p 182) defines institutions as

> ...sets of common habits, norms, routines, established practices, rules or laws that regulate the relations and interactions between individuals, groups, and organisations. They are the rules of the game.

The analysis of innovation systems focuses strongly on the institutional setting in which innovative activities are performed, mainly asking the question, 'who does what?' with respect to innovation. The different actors involved (government, research institutions and firms) perform complimentary activities and knowledge is exchanged between them either uni- or multidirectional, thus creating an overall innovative environment.

A cluster, as opposed to a system (which is much wider), is a group of firms within a small geographic region, all participating in the same industry or a closely related group of industries (Rugman and D'Cruz 2000). Porter's (1990, 2004) diamond concept focuses on the aspect of the environment itself and how this environment can become supportive of successful clusters of firms, and in which a nation achieves international competitiveness through the development of each of the four dimensions described in Figure 3.3 below.

Figure 3.3: Porter's concept of the microeconomic environment



(Source: Porter 2004, p 22)

This diamond corresponds with Rugman's and D'Cruz's (2000) Five Partners Network, as the network idea states that most of the factors mentioned in the diamond can be created directly or indirectly by a flagship firm in its interaction with the other partners. A flagship firm in this context is one firm, presumably the MNE subsidiary with its superior knowledge base, which through linkages and competition with indigenous firms, the local government, and extramural institutions forges a network through which knowledge spillovers are facilitated. Markusen (1996) asserts that industrial districts, in which a cluster of smaller firms surrounds one larger firm (Rugman and D'Cruz's flagship), can be drivers of regional development; in the context of this research it is the notion of *hub-and-spoke* districts (where a set of small and medium enterprises (SMEs) surrounds a large, maybe international, firm) that seems interesting in the context of developing innovative capacity in the Baltics. But while Porter assigns the main responsibility for creating and improving this environment to the country's government (and some things can obviously only been done by it), Rugman and D'Cruz find that much can be achieved by the business networks and their flagships. To distinguish between the different possible clusters that may evolve, Table 3.2 below presents a rough typology, on which the following discussion centres.

Table 3.2: A cluster typology

	Mega Cluster	Local Network	Knowledge-based
Level	macro meso	micro	micro meso
Driving force	competitiveness of the area	Competitiveness of enterprises	Technological development, innovation
Origin	Mapping studies, Strategic analyses	Enterprise dynamics	Knowledge flows science-industry
Main components	Sectors, value chain, firms and other organisations	SMEs (other firms)	Enterprise and research centres
Success factors	Critical mass, factor conditions, demand, adapted labour market	Geographic proximity, entrepreneurship, social capital, communication, vision, leadership, competence base	Adequate regulatory and institutional framework, efficient intermediaries, match in specialisations, scale economies, knowledge flows

(Source: adapted from Nauwelaers 2003)

The general uncertainty that particularly smaller MNEs face in a transitional environment makes them seek investment rather than local partnerships. Trust, however, is an essential ingredient when networks or relationships are to be formed (Kozak and Cohen 1997), but also differs between cultures (Henrich 2000) and declines significantly when different nationalities are concerned (Glaeser et al 2000). This is also applicable to MNE subsidiaries in different countries, suggesting again that cultural attitudes facilitate the exchange of knowledge better than 'just' belonging to the same MNE (Barner-

Rasmussen, Björkmann, and Li 2002). It is notable that the three Baltic States range at the lower end of the European spectrum regarding the general trustfulness of people, while the Nordics range at the higher end (van Schaik 2002). In their study of cultural differences between the Netherlands and four CEE countries, Kolman et al. (2003) confirm a significant cultural gap between Western and Eastern Europe; adding that while Socialism had a marked influence on CEE, this 'disturbance' will fade eventually. Trust, however, is strongly influenced by geographic and cultural proximity. Where firms are located close together, they will trust each other more readily and forge stronger relationships, which in turn are re-enforced by stronger integration and the exchange of relevant knowledge (Bönte 2008). So, while a feel for the culture of a host environment helps forging links initially, it is both physical closeness and strong integration that creates trust and knowledge transfers.

Assuming that the MNE subsidiary in the Baltic economy creates a network of the sort that Rugman and D'Cruz (2000) describe, linkages with local firms (suppliers, customers, competitors) and the non-business environment (government, universities) will create spillovers and by that create knowledge and thus add to the knowledge base within the Baltic host environment.

This view is challenged by Beaudry and Breschi (2003), whose findings for clusters in the UK and Italy show that it is not necessarily the existence of a cluster or network that leads firms to innovate, but rather an 'innovative' environment in which they operate, which adds itself to the assets of the firms operating in it (Kogut 2000). This environment, however, is shaped partly by culture and partly by targeted policies of the government and thus is country-specific, depending largely on the national attitude to knowledge creation and diffusion (Pollard 2006, Dosi, Pavitt and Soete 1990, Lundvall 1992, Nelson 1993). Supporting this finding are Sorenson and Singh (2007), who in their study of citations between US patents, find that it is less social networks and more the factual disclosure of knowledge in the form of readily available patents that facilitate knowledge diffusion, thus contradicting the notion of networks as the main catalyst of spillovers.

Porter (2000) and Malerba (2002) both make the point that not only do social or geographical networks matter, but rather it is a shared set of needs, mind-sets, and awareness that tends to facilitate the emergence of highly specialised clusters.

Beaudry and Breschi (2003) go even further, reporting that their study of clusters in the UK and Italy suggests that clusters can even hinder innovative efforts, if there is a certain amount of attempted free-riding by non-innovative firms in the industry, whereas innovative firms in related sectors spur innovative efforts. And clusters do not necessarily have to be 'high tech', as Porter (1998) and Lundvall et al. (2002) note. Specialisation can occur in fields where knowledge and innovation are incremental, if that is the tradition in the host country, or the technology gap is too wide to absorb cutting-edge knowledge. Indeed, Leydesdorff and Fritsch (2006) find that for Germany's regions, medium-tech manufacturing provides the most accurate indicator for the knowledge economy, as opposed to high-tech-manufacturing, which tends to follow its own, separate development.[8] On the other hand, Audretsch and Feldman (1996) report a higher propensity to cluster for industries where knowledge externalities are more important, i.e. high-technology, for the US.

This could mean that only high-technology industries would at this early stage be able to form clusters in the Baltic States, but as the building of the knowledge base takes some time, so far mainly medium technology networks should have been formed – and innovation systems proper will only follow at a later stage. Still, the actors involved need a common conception of the technology needed and applied, and with this

[8] This confirms the sometimes slightly ambiguous nature of the IDP and its stages discussed above.

common awareness, they create the 'sticky place' Markusen (1996) refers to. It is the shared attitudes that bring the actors together, and through this re-enforcing development towards a cluster or network is induced. Walker, Kogut, and Shan (1997) find further evidence in their study of network formation in the biotechnology industry in the US. Initial decisions about co-operation between firms (and others) tend to be persistent and stable, so that networks have centres around which they develop. Should a subsidiary become a flagship in a network within the Baltic States, it is likely to dominate that network for a while and direct its overall development. Narin and Breitzman (1995) support this by finding that patenting activities are highly concentrated between only a few firms or institutions (Meyer et al. 2005), and that patenting roughly follows Lotka's Law[9], so that it can be assumed that some highly innovative firms will always 'stick out' of a quite large mass of averagely innovative firms around them.

Gittelman and Kogut (2003) analyse the roles that the different actors have within the cluster and find that it is small and research-intensive firms that mostly bridge the gap between science and actual innovation. While researchers at universities or research institutions do produce inventions, it is the small firms that often make these commercially viable; acting practically as a selection stage and building up a stock of commercially viable knowledge. While science and innovation do not necessarily correspond, small and versatile firms act as the 'glue' that integrates an innovation system. Amesse et al. (1991) partly confirm this when they find that Canadian patents are most successful commercially when the actual inventor turns entrepreneur and markets the innovation himself; this is partly due to the structure of the Canadian economy, which is more resource- and less knowledge-based. At the same time, entrepreneurship and good relations between universities and the business sector play an important part in the

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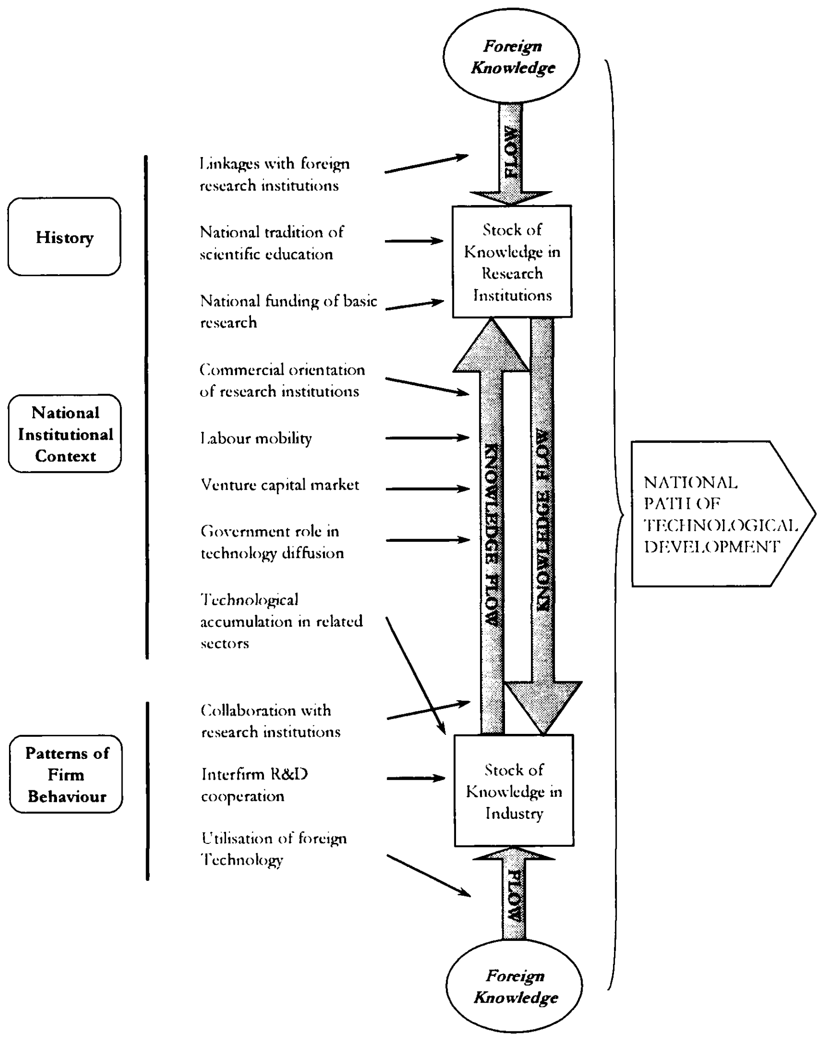
[9] Lotka (1926) postulated an inverse square law of scientific productivity, or that the number of people writing n papers is proportional to $1/n^2$.

commercialisation of inventions in Germany (Mueller 2006). On the other hand, it is not necessarily public support that guarantees commercial success for inventors, as evidence from Finland suggests (Meyer 2005). In general, it is SMEs that, because of their flexibility and size, tap more into local networks and find niches more easily (Almeida and Kogut 1997). However, some institutional mechanisms of knowledge transfer between the sectors of an economy need to be in place to facilitate beneficial exchanges (Pollard 2006).

3.6 The Building of National Innovative Capacity

Cantwell and Iammarino (2003) find both forces at work: The ease of communication and a 'common ground' favours localised clustering, while the globalisation of technology makes these regional developments possible in a wide array of places, i.e. wherever a favourable environment for such development can be created, taking into account the multitude of factors that influence the technological development, which are depicted in Figure 3.4:

Figure 3.4: Factors that influence the technological development of an economy



(source: adapted from Bartholomew 1997)

Several dimensions of the 'catalysts' for knowledge diffusion and the building of innovative capacity become apparent. The ability of indigenous actors to utilise knowledge from abroad depends as much on the institutional set-up (research and government institutions and the wider legal context) as on the 'culture' of knowledge creation and diffusion, i.e. the willingness to collaborate and share. A country without a tradition of research and innovative activities will find it much harder to tap into foreign knowledge, even if it were willingly shared.

Both the competition effect and the linkage effect can only work if there is the capacity to learn in the local, i.e. the Baltic economy, that is, if an innovative subsidiary finds a 'breeding ground' in which to settle.

This innovative capacity of a country depends on several factors, as Furman, Porter, and Stern (2002) find in their study of foreign US patenting. Besides the factors that active government policy can influence, it is also the knowledge stock, the technological profile, and the institutional make-up of innovative actors that shape a country's success internationally. Applying the same methodology, Hu and Mathews (2005) confirm the findings for East Asia, yet suggest that for countries that are in the process of catching up, some government-sponsored R&D is beneficial to the development of national innovative capacity.

With respect to technology transfer from the source countries to the Baltic States, Damijan at al. (2003) examine the influence of FDI, R&D and trade on the knowledge transfer to transition economies. They too find that is mostly through direct links between firms such as alliances and not through the mere presence of FDI that technology flows between firms. The presence of a foreign subsidiary will put pressure on indigenous firms to innovate themselves: whether this is to compete with the MNE or because they are part of the production chain does not matter – to match the subsidiary's technological standard, they will have to follow in some way. Czarnitzki and Kraft (2004) find in Germany that it is actually usually the challenger in a new industry that invests even more than the incumbent. For the Baltics, this will not be such a clear-cut finding, as it remains to be seen who the challenger is: the MNE that enters the market, or the indigenous firms that try to compete or adjust? The relation might change over time, but what seems clear is that the level of innovative activity within the Baltic host country will be affected.

Research by Malerba, Breschi, and Lissoni (1998) into the patenting activities by firms in several industrialised countries shows that innovative efforts follow largely those of economic activities, with a 'core' of about 70% of all innovations within the firm's/ cluster's own technological field and a 'fringe' of about 30% exploring other, if related fields. As a foreign flagship is likely to produce the bulk of the innovation initially, it will by that form a specialised profile of an emerging network.

This implies that in the presence of knowledge spillovers from more advanced MNE affiliates to developing domestic firms the capabilities of the MNE would be transferred to the indigenous firm to some extent, i.e. the MNE's particular technological strength should be partly picked up in the Baltic host country. While it is the technological 'profile' of the host country that attracts FDI of a certain specialisation to begin with, the foreign affiliate – provided it finds the technology gap not too large and is willing to forge local linkages – will in turn shape its surroundings through subsequent knowledge spillovers. Thus, the technological profiles of the host and source countries should converge eventually, as through interaction and spillovers both MNEs and domestic players develop the same strengths (Radošević and Kutlača 1999, Co 2002, Patel and Pavitt 1997, Cantwell and Kosmopoulou 2003).

Building on the notion of (1) networks/ clusters and (2) absorptive capacities, it seems reasonably safe to assume that key investments in either or all Baltic economies eventually lead to the emergence of innovation systems of sorts – if rudimentary ones –, induced either through competition, imitation (inter-network spillovers), or the transfer of knowledge between partners (intra-network spillovers) (Walker, Kogut, and Shan 1997, Anand and Kogut 1997). Högselius (2002) describes the formation of a sectoral innovation system in the Estonian telecommunications industry, yet he does not focus on its determinants but rather on the process itself.

3.7 Conclusions

This chapter has outlined both the theoretical and empirical approaches that are important for explaining the development of the three Baltic States from centrally planned Soviet republics towards innovation-driven economies. By making use of the IDP and a systems-based approach that conceptualises the knowledge flows into and within the countries, it focuses on a development that is initially induced from the outside, in this case mainly the geographically and culturally close Nordic countries; and which is then re-enforced from within the host economy, where the 'imported' knowledge meets an environment that both absorbs and later enhances this initial input. By emphasising particularly the importance of proximity between sources and receivers of this knowledge and the knowledge flows themselves, this study follows Lall's (1996) argument that while the IDP is a useful approach to explaining the economic development of host countries, there are other factors that will broaden and enhance the understanding of the underlying processes.

More generally, this study contributes in several ways to the existing body of knowledge. Firstly, the theory of the IDP is applied to transition economies that have already come some way in their transformation from the socialist system to a western-style economy. Estonia's outward FDI is growing steadily, although it has yet to reach the third stage of the IDP, where the NOI turns neutral and then positive for the first time. Latvia and Lithuania lag behind Estonia, with a decidedly negative NOI (UNCTAD). However, it is the comparison between the three countries as well as the inclusion of more intangible assets that augments the analysis, which in the original IDP would be restricted to 'just' FDI. It is the second and the transition to the third stage that are in the focus of this study, where domestic development really starts, that are of most interest in this context, and this work will analyse this development in depth.

Secondly, by including proximity in the analysis, the relationship between host and source countries of both FDI and knowledge is examined in depth. The factors which attract investment and knowledge to countries that are still in an early stage of the IDP are explored, including the influence of the specific relationship between source and host country. While geographic and cultural proximity both play a role in attracting these assets to the Baltics, it is cultural and technological proximity (or more generally, a closeness of mindsets) that influences the actual absorptive capacity of the host country environment and the subsequent transfer of knowledge and technology. The ability to build upon the knowledge flowing into the country depends on the current stock of knowledge and the technological readiness already present, which in turn manifest themselves in the technological profile of the country's innovative activity up to then. Furthermore, if host and source country exhibit similar technological strengths and weaknesses, knowledge will be more easily transferred between the individual actors in the innovation system.

This leads to the third contribution: the integration of intangible assets, in this case innovative output in the form of patent applications, into the theory of the IDP. Starting from the presence of FDI and trade, the analysis then focuses primarily on knowledge flows, applying the original IDP reasoning to the examination of these knowledge flows, thereby updating the original IDP approach with a newer systems approach. While the basic hypothesis of the IDP – that inputs from 'outside', demonstration effects which can be induced through FDI, lead to domestic development and eventually international competitiveness – remains unchanged, a more evolutionary concept of learning and accumulation of knowledge augments the original approach. Furthermore, the role of international knowledge flows as a catalyst for the formation of an innovation system in the host country is examined.

With these propositions in mind, the following chapter explains the methods and data used in analysing the development of innovative capacities in the three Baltic States.

CHAPTER 4

METHODOLOGY

4.1 Introduction

In order to make the contributions to the existing body of knowledge outlined at the end of the preceding chapter and be able to conduct a meaningful study into the development of the Baltic States from Soviet republics to economies able to compete in the global economy, a versatile yet consistent approach is needed. The aim of this chapter is to present just such an array of appropriate methods adopted to fulfil this aim, which will, over the course of this study, create a consistent, comprehensive, and sufficiently detailed insight into the knowledge flows and generation during the transition process between 1992 and 2004. As the EC, the OECD, UNCTAD and most other supranational bodies emphasise the importance of innovation for national growth, development, and, more generally, 'well-being', it is reasonable to take an approach that centres on this particular argument. Patent applications have been chosen as the most reliable and comparable indicator for inventive out-put in the area because of their consistency and sufficient time coverage.

The following sections outline how a comparative country study of three countries in transition and their dependency on influences from the outside world can be centred on this one major indicator. However, while patent applications form the focal point of this study, other data, such as FDI, are used to establish this focus. As the theoretical considerations have highlighted, FDI and patents are usually linked, and as such integral, if not entirely centre-stage. Other data, for instance on trade and economic environments, augment and support the analysis.

The first section discusses the merits and shortcomings of patent data as a proxy for inventive, even innovative capacity and its development. The legal peculiarities and their effects on the handling of the data are discussed, as well as more conceptual issues that arise when dealing with patent applications rather than grants, as this study does. Furthermore, the sources of patent data are presented and their relative merit for this work critically reviewed.

Following that, the construction of the patent database, one of the centrepieces of this study (the other being the integration of the different parts of the analysis), is explained and its features (as opposed to the ready-to use online databases from which the data has been extracted) highlighted. Most of the following analysis is based on this database and would not have been possible without it.

The chapter then turns to the actual course this study takes to analyse the patenting dynamics in and around the Baltic States and to answer the question: How successful are the countries in their efforts to create fully developed, knowledge-driven economies? The sequencing of the research is explained, where one methodological approach and its respective findings lead to more specific questions as well as more tightly focused investigations. It is at this point that the proposed development sketched out in the preceding chapter is translated into a methodological approach that tries to identify and trace knowledge inflows to the Baltic States and their determinants and their subsequent influence on shaping the formation of innovative capacity in the three host economies.

First of all, knowledge inflows and the factors that determine them (such as particularly FDI) are analysed with the help of a panel data regression model, thus integrating intangible assets into the FDI-centred IDP. This is followed by an in-depth examination of both those knowledge inflows and the generation of knowledge within the Baltic host countries, which is done mainly by the use of indices of competitiveness, or revealed technological advantage (RTA). Several other measures are taken to augment this analysis, such as detailed descriptions of actual patent applicants and bibliometric approaches. This helps understanding the workings of the TDP concept within the context of the transitional processes in the Baltic States.

The last section summarizes the methods presented and leads over to the empirical part of the study.

4.2 Patents

The main focus of this study lies on patent data, or rather, inventive activity as can be captured in patent applications. Three kinds of patent data are used, defined by their respective origin and 'target': domestic applications filed within the Baltic States, 'international' (i.e. European or PCT) ones that originate in the Baltics, and applications that originate outside the Baltic States (either in one of the international regimes or one source country under consideration), which are then extended to at least one of the three host countries.

To clarify these differences and how the characteristics of various patent regimes affect the data, the following sections will provide a brief overview of the systems, the sources which provide the actual data, and how it is organised and used in the context of this study.

4.2.1 *The Use of Patent Data in this study*

Put simply, a patent guarantees the inventor to exclusively reap the gains of their invention, whether in the form of increased sales or cost reductions – it aims to internalise the benefits of R&D (Landes and Posner 2003). It grants the owner of the patent[10] a monopoly for a certain time (usually about 20 years) and in a certain region (usually a nation) where only they can exploit the benefits to be had from the invention. A patent system thus aims to create incentives for creating commercially viable knowledge (Smith 2005).

The advantages and disadvantages of using patent data as a proxy for measuring innovation have been widely debated in the literature (see, for instance, Pavitt 1988, Griliches 1990). Patent data is consistent and stable over time; it thus presents a very reliable source of information. Given that the data used in this study is collected and stored by the EPO and the WIPO and governed by WIPO regulations (or is in accordance with them), it is as consistent as it can be across different patent regimes and countries (different legal practices with respect to details notwithstanding).[11] There are weaknesses, however, the main one being that as an indicator for innovative, even 'only' inventive activity, patents provide a quite limited picture. Patents measure only a very narrow slice of the phenomenon – namely commercially exploitable inventions from people or organisations that can afford to take out a patent. Art. 52(2) and (3) EPC postulates that one condition for the grant of a patent is the existence of an inventive step (EPO 2007):

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[10] This does not necessarily have to be the inventor(s) themselves, particularly not if the invention is made as part of firms' R&D efforts and thus rests within the ownership of the corporation or university which employs the inventor.

[11] Pottelsberghe (2009) highlights the weaknesses of different legal practices when discussing the shortcomings of the European patent system: Firstly, patents can be contested in the various member states of the EPC separately, thus creating 'uneven' protection. Secondly, this unwieldy practice of different national jurisdictions involved results in much higher costs for the applicant, and draws potential applicants away from the European and towards the international (PCT) system.

> (2) The following in particular shall not be regarded as inventions within the meaning of paragraph 1:
>
> (a) discoveries, scientific theories and mathematical methods;
>
> (b) aesthetic creations;
>
> (c) schemes, rules and methods for performing mental acts, playing games or doing business, and programs for computers;
>
> (d) presentations of information.
>
> (3) The provisions of paragraph 2 shall exclude patentability of the subject-matter or activities referred to in that provision only to the extent to which a European patent application or European patent relates to such subject-matter or activities as such.

Many innovations that constitute 'merely' new combinations of known ideas in the Schumpeterian (1942) sense are thus left out of any analysis. Schumpeter's notion of new combinations is much broader and includes people putting 'old' things to new uses, something not uncommon in the early years of transition in the Baltic States, with a prolonged recession and the slow emergence out of the Soviet-style economy of shortage.

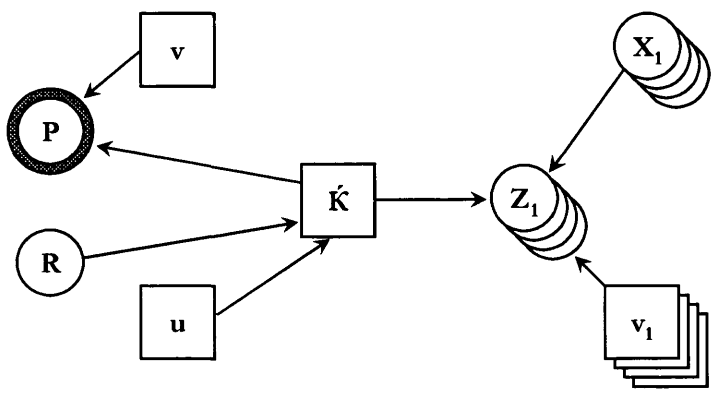
In addition to that, not all patented inventions are actually marketed successfully. Kleinknecht, van Montfort and Brouwer (2002, p 112) argue that

> It is obvious that the patent indicator misses many non-patented inventions and innovations. Some types of technology are not patentable [...]. On the other hand, what is the share of patents that is never translated into commercially viable products and processes? And can this share be assumed to be constant across branches and firm size classes? Moreover in some cases patent figures can be obscured by strategic behaviour: a firm will not commercialize the patent but use it to prevent a competitor patenting and using it.

The last point has become more prevalent in recent years. Rising numbers of patent applications and grants worldwide are partly the result of a different attitude that mostly firms have developed towards intellectual property – it is now strongly perceived as not only a way to protect one's own inventions, but as a strategic asset that generates income by itself and secures market positions and market power (Anon 2005).

Griliches (1990) mentions another possible difficulty that arises when using patent data, which nevertheless builds on the aforementioned one. He puts the inherent weaknesses of the indicator in the context of the direction the actual research takes – i.e. what patent data is supposed to capture. It can be employed both as a measure of output and of input, as Figure 4.1 illustrates.

Figure 4.1: The knowledge production function (simplified)

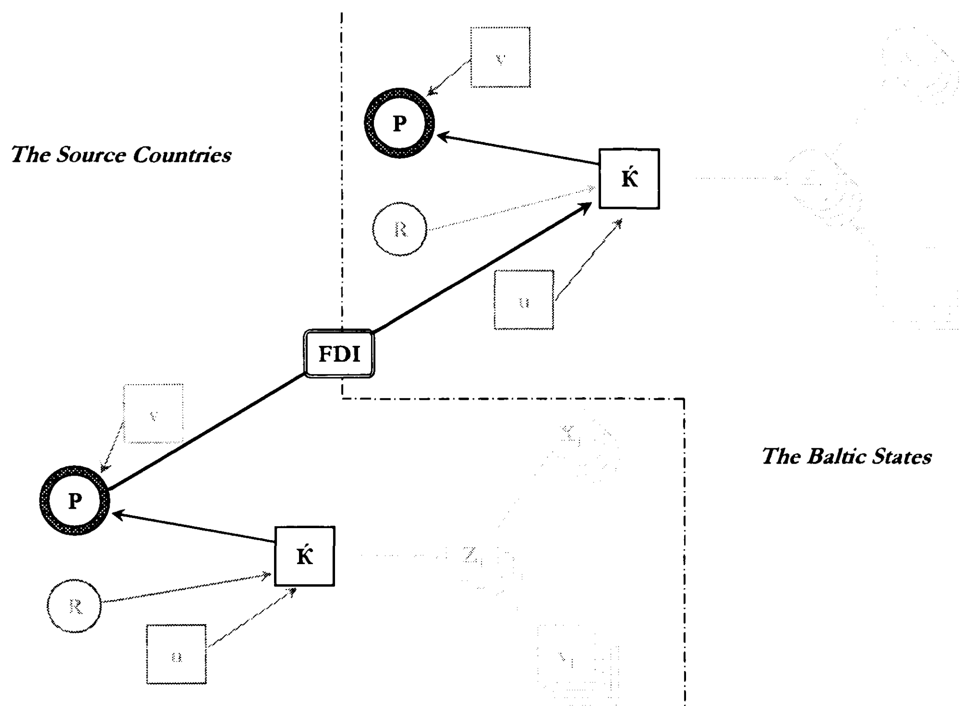


(Source: adapted from Griliches 1990, p 1671)

Griliches's view is that in most studies, it is actually knowledge (Ḱ) – or the additions to commercially viable knowledge – that is the focus of analysis, with patents (P) only being one tangible part of this knowledge. The number of patents in turn also reacts to outside influences independent of R&D (v). Ḱ can either be treated as the result of (or dependent on) R&D expenditures (R) and other, often unobserved, influences (u); or it can be seen as the factor that in turn influences expected or realised benefits of innovation (or inventions) (Z_1), which in turn are partly determined by other observed (X_1) or unobserved (v_1) factors.

This study's focus is the left half of the figure in two ways: Patent data is indeed used to proxy knowledge and the accumulation thereof in the Baltic States. Yet it is also used to proxy knowledge inflows to the countries, as often facilitated by FDI. As Figure 4.2 illustrates, the left part of the knowledge production function is thus duplicated to represent two countries rather than one and the knowledge creation within them:

Figure 4.2: Focus of this study as part of Griliches's knowledge production function



Griliches describes a straightforward mechanism of knowledge creation, which can either take place within one country or includes inventive efforts in several countries separately. This study is particularly interested in how knowledge transfer is facilitated across borders and how knowledge generated in countries other than the Baltics helps in the development of innovative capacity within the Baltic States. In order to illustrate this course of investigation, Griliches's original figure is split geographically as well as temporally.[12] In the original figure, the main interest of this study – knowledge transfers facilitated through FDI – would be subsumed under influences other than R&D on the

[12] 'Temporally' in this context simply means that there will usually be a time lag between knowledge creation in the home country and the subsequent knowledge creation in the Baltic State – apart from general lags in the patent grant and extension procedure, the FDI has to come into effect, as well.

domestic knowledge stock (u) or patenting (v). These knowledge inflows are now 'extracted' from u and scrutinised more closely.[13] The main chain of thought, as explained in the theoretical framework presented in the preceding chapter is thus as follows: Knowledge created outside the Baltic States and measured in patent application counts is transferred to the Baltic States, mainly through FDI (although other determinants are explored as well, distance in particular). Through MNEs' interactions in the host countries, part of this knowledge spills over and adds to the knowledge stock within the Baltic States. As this knowledge stock is an abstract item just as much as the knowledge stock in the source countries, it is again patenting activity, this time within, or originating in the host countries, that is used to proxy these activities. Keeping in mind the weaknesses of patent data as an indicator for innovative capacity (although Soete and Wyatt (1983) for instance, find bias resulting from the use of patent data to be smaller than feared), it becomes possible to gain an insight into the mechanisms of spillovers at work in the Baltic States. Absorptive capacity, on the other hand, is not traced explicitly through this model; rather, it is assumed implicitly. While spillovers that translate into inventive activities in the host economies imply the presence of some absorption, it is out with the scope of this study's approach to test for it more rigorously.

The data used in this study represents patent applications rather than patent grants.[14] The use of patent applications is necessary given the relatively short time period under investigation, 1992 to 2004. A recognised disadvantage of applications is the neglect of the varying success rates of countries in obtaining patent grants (Archambault 2002) –

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[13] The knowledge inflows do not equal u, meaning that u is not eliminated completely. One can still assume other unobserved factors to be at work, yet these are not of particular interest here.

[14] Obtaining a grant can be lengthy, as objections to the published application by third parties, although lags vary. Three years is a usual and seldom undercut time, but the time period between priority/ publication date and grant can easily be several years – in the PCT procedure, a 'grant' only means the entry into the national phase.

anecdotal evidence suggests that particularly in Latvia and Lithuania applications are filed for almost everything that is considered a 'new idea' – this was particularly prevalent in the early years of transition, when the patent regime had just been established and inventors were still unfamiliar with its rules and opportunities. The ideas which patent applications were filed for might have well been at that time closer to new combinations of the Schumpeterian kind than to any non-obvious inventive steps.

Thus, the use of patent application data rather than grants involves dealing with noise, but it is the only feasible method to ensure the coverage of a sufficiently long time period as well as comparability between countries. In order to address the inherent weaknesses of patent application data discussed here, the data is analysed from as many perspectives as possible: domestic as opposed to international patent applications, with both groups in turn being broken down by the geographic origin of the knowledge contained within the application, as indicated by the documents' priority numbers. These various angles of analysis as well as the specific characteristics of patent applications are discussed in detail below. However, Guellec and van Pottelsberghe de la Potterie (2001), in their study of the internationalisation of technology, show that empirical results based on applications filed with the EPO are very similar to those based on USPTO patent grants.

4.2.2 Legal Aspects and Impact on the Use of Patent Data

The legal characteristics of IP protection through patents, particularly if international protection is sought, make the handling of patent data more difficult. Several different patent regimes are used in this study, with their respective procedures of examining and eventually granting patents impacting on the ways in which the data can be utilised. Furthermore, the existence of several routes a patent holder can choose from to extend protection from the original country in which the invention was made (or first protected) to one or more Baltic States leads to some parts of these knowledge flows becoming unobservable, as illustrated in Figure 4.3 and explained in more detail below. The various options available to patent applicants also make it difficult to establish a firm grip on possible lags between the original inventive step and achieving its protection abroad. To understand these options and resulting lags, let us first have a look at the actual procedure of obtaining a patent in the patent system under investigation.

In principle, the patent grant procedure is relatively straightforward. As this study deals with patent applications, the actual procedure of investigating the claims and subsequently granting or refusing the patent is mostly irrelevant. What is relevant, though, are the time lags between filing an application and its publication by the patent office, as well as the conceptual and legal differences between the types of patent application under investigation.

All patent systems relevant to this study, i.e. those governed by the WIPO (PCT patents), EPO, and the Estonian, Latvian, and Lithuanian patent offices apply very similar or even identical procedures when dealing with patent applications, with the exception that a PCT patent application has two phases to complete before it is granted. Generally, once a patent application is filed, its form and content are examined by the relevant patent office, and if deemed sufficient, the application is published roughly 18 months after the filing date (EPO 2007 – Art. 93, WIPO 1970 – Art. 21, Estonian Patent Office 2009[15], State Patent Bureau of Lithuania 1994 – Art. 21, Patent Office of Latvia 2007 – Section 35 §1).[16] However, any time between three and 18 months may elapse between filing and publication, so that it is impossible to establish a 'general' lag at this point. Accordingly, this study takes publication dates rather than priority dates as the basis for

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15 The Estonian Patent Act is not available in languages other than Estonian, so this particular information had to be taken from the patent office's official web site.

16 All patent acts and treaties in question speak of 18 months. However, the expressions vary between '18 months', 'not before 18 months', and 'immediately after 18 months'.

analysis. This is done because on the one hand, priority dates cannot be searched in some databases and on the other hand because the publication date is the best approximation of the 'appearance' of the knowledge in the public domain.[17]

What is more, the filing date is not always the base date for determining the time that elapses before the publication of the application. If – as in the majority of applications – priority is claimed, it is the priority date, rather than the filing date, that is considered the starting point of the process.

The priority claimed in a patent application is a crucial indicator in this investigation. It is used to determine the origin of the knowledge codified in the patent. The Paris Convention, originally signed in 1883, states in Art. 4, par. A (1) that:

> Any person who has duly filed an application for a patent [...] in one of the countries of the Union, or his successor in title, shall enjoy, for the purpose of filing in the other countries, a right of priority during the periods hereinafter fixed.

And further in paragraph C:

> (1) The periods of priority referred to above shall be twelve months for patents and utility models, and six months for industrial designs and trademarks.
>
> (2) These periods shall start from the date of filing of the first application; the day of filing shall not be included in the period.

On the one hand, the right of priority complicates the handling of patent data[18], as it makes any establishment of reliable lags between the filing of a patent application and its publication impossible; on the other hand, priority information is invaluable, as the priority number is included in the publication and identifies the location of the first fil-

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[17] The concept of priority claims is discussed in more detail below.

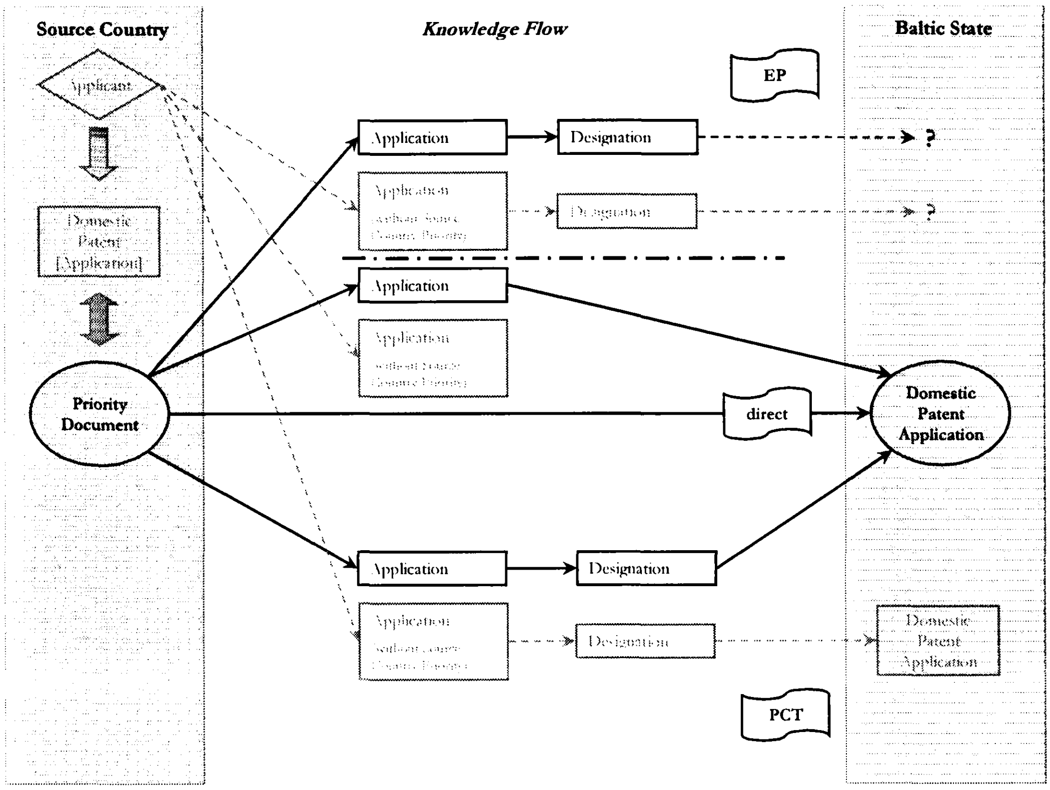
[18] The US concept of priority works differently – it is an internal priority, which is not governed by international or regional regimes. Here, the applicant does not have to file a full application, but only a provisional one, which establishes a priority date but does not start a full grant procedure. Only if the applicant decides in due course to pursue a full application does the process start in earnest – but then the priority date is the one of the earlier, provisional, application. Hence the decision not to base this study on US patenting.

ing. Thus, the geographic origin of the knowledge contained in a patent application can be traced and knowledge flows between countries captured (although the actual date of the priority filing is ignored as the publication date is recorded in this study). There are of course other possible approaches to capture this origin; however, due to the design and scope of the databases which provide patent data (which is described in the following section in more detail), priority information was found to be s superior proxy for this study.

Another difficulty that arises when dealing with patent applications in different patent regimes is the different character that the patents have due the different procedures governing them. While the Baltic and European patents follow a straightforward structure of filing (with or without priority) – application publication – examination – grant decision, the 'world patent' administered by the WIPO works differently. It is not a worldwide (or PCT-covering part of the world) patent, but goes through two phases of the grant procedure: the international and the national phases. The international phase is largely the same as in the other four patent regimes, but when the decision whether to grant is made, a positive outcome means that no patent as such is granted, but the application enters the national phase, i.e. the application is forwarded to all PCT contracting states in which protection was initially sought. There, it becomes a 'mere' national (or in the EPO case, regional) patent application with (at least) a PCT priority and is processed accordingly. The process allows for cost savings for the applicant, as they do not have to pay fees for each national filing, but pay for a bundle of applications, administered initially by the WIPO (WIPO 2004).

To highlight the consequences for identifying and collecting the data used in this study, Figure 4.3 shows the different routes by which knowledge can flow from a source country to a Baltic State and charts what knowledge flows can be traced (in black) and which ones will necessarily be omitted due to the structure of the different patenting procedures (in grey).

Figure 4.3: Patenting routes between source country and Baltic State



The black, direct arrow in the centre of the figure represents the most direct route a knowledge flow can take: A domestic patent filed for in any source country is extended to a Baltic host country by filing an additional application with the Baltic patent office in question. The source country application becomes the priority document of the application in the Baltic State. As priorities can be 'chained together', i.e. successive applications made in different host countries at different times[19], it is always the earliest priority date that is taken to indicate the document's origin.

The lower half deals of Figure 4.3 with the PCT route. Provided the PCT application rests on an earlier domestic filing in the source country, a national priority number

[19] This can of course also be due to different times of publication in different host countries, depending on their domestic patent granting procedures and time frames.

again exists. Once the application passes the international stage of the PCT process and is aimed at the Baltic States (exclusively or in addition to other national designations), it translates into a national application there, with a national application number. These national applications usually have both a PCT and a source country priority number, so that the international phase of the PCT grant procedure can be seen as a simple 'detour' the knowledge flow takes. If, however, the application is filed directly with the WIPO and therefore does not claim a source country priority, the knowledge flow becomes invisible, as the remaining PCT priority number does not indicate a source country. It is possible to include the residence and/ or the nationality of the applicant, but this would lead to inconsistencies in the approach. Furthermore, as detailed in the following section, the databases do not easily accommodate this approach.

The upper half of Figure 4.3 accordingly charts the EP route for knowledge flows. It is split again, as the Baltic States' status within the European patent system has changed in the time under analysis. Generally, tracing the origin of an EP application is the same process as with a PCT one, with the same weakness of invisible flows when no national priority is claimed in the EP filing. It becomes a bit more complicated when the EP application is aimed to cover the Baltic States. First of all, a European patent covers all EPC signatory states by default, so that it does not show as domestic patent applications as a PCT patent would – the flow becomes invisible again. However, while all three Baltic States signed the EPC early in their transition process, they started as so-called extension states, a status that falls short of full membership. An application could optionally include the Baltics as designated countries in which EP protection was sought, but often a separate application is still filed in the Baltics – despite an EP application. This visible detour is depicted in the lower part of the EP route. Once the Baltic States became full members of the EP system (in the early 2000s and thus towards the end of the time period investigated), knowledge flows would again become invisible, as the Baltics would be subsumed under an EP application. This is the one true loss of data; however, as will be seen, the Baltic States are usually targeted through PCT flows[20], which makes the lost EP flow bearable.

4.2.3 Sources of Patent Data

Fully searchable and often free-of-charge online patent databases have been made available by most major patent offices in the world by now and have been becoming more and more popular and useful for studies of innovative activities (Meyer, Utecht and Goloubeva 2003). This research relies heavily on the features they offer. This section introduces the main databases used and explains their merits and weaknesses for this study.

4.2.3.1 Esp@cenet

Esp@cenet, the online database of the European Patent Office, offers access to over more than 50 million patent documents worldwide. Its capacity for the purpose of this study is limited, so that certain 'detours' become necessary.

Given the assumption that the priority of a patent can serve as a proxy for the origin of the knowledge it contains, the main focus of the queries performed is in the priority number of any document. In order to cover all possible patents that originate in any country, the 'Worldwide' database was queried.

The 'Advanced Search' mask offers ten search fields and the choice of the database to be queried (in this case 'Worldwide') to the user. These are shown in Figure 4.4 below:

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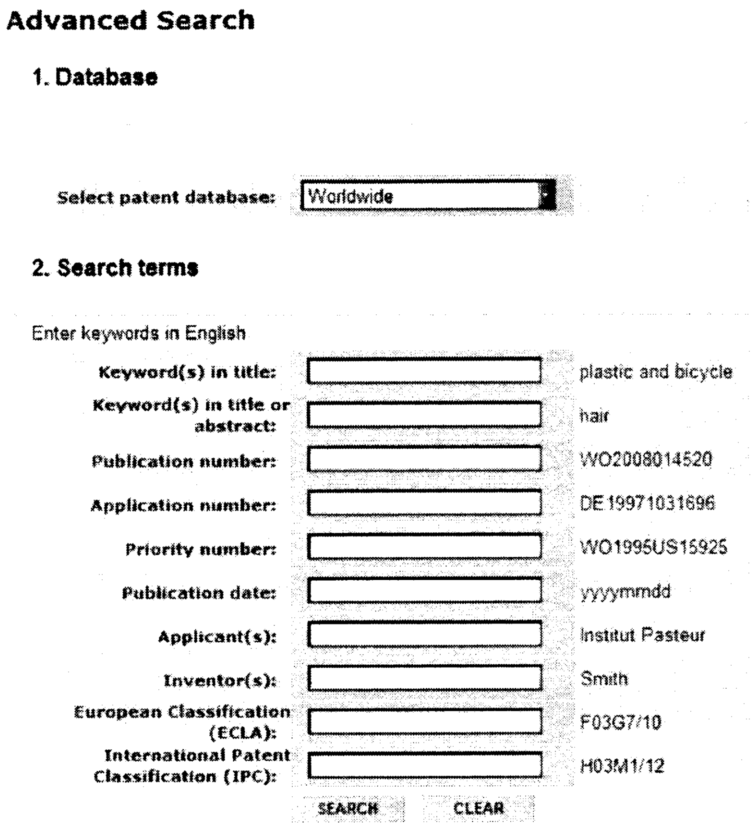
[20] This is again due to the shortcomings of the European patent system, which make the EP route more expensive and risky for applicants (Pottelsberghe 2009).

Figure 4.4: esp@cenet Advanced Search mask



(Source: http://ep.espacenet.com/advancedSearch?locale=en_EP)

The major difficulty in querying the database is its way of computing queries and displaying results.

Firstly, only the fields 'Keyword(s) in title' and 'Keyword(s) in title or abstract' explicitly allow wildcards. It is possible though to insert only the two-letter country code into one of the number fields ('Publication number', 'Application number', or 'Priority number'). Parts of the number (e.g. just the priority date contained within the priority number) itself cannot be searched for. As the application number consists of the country code and the filing date or a random number, it would have been convenient to be able to query the database for the country code plus the year of filing (the search mask only offers the publication date that varies in relation to the filing date, depending on the kind of patent and the relevant grant procedure). Thus it is impossible to find priority documents from a specific year.

However, as esp@cenet is used to determine the patterns of priority in the Baltic States over time, this limitation does not really distort the findings.

A second shortcoming of the Advanced Search mask is its inability to split searches into portions smaller than one year of publishing. It is impossible, for instance, to search for patent documents published in one particular month; only a particular year would be possible. However, as the result list is sorted by the documents' upload to the database, it is still possible to identify a particular month relatively quickly (although the occasional late upload of an already published document might result in minor distortions). An additional difficulty this results in is esp@cenet's inability to display more than 500 results at a time. It states the overall number of results (or an approximation thereof) but will only give the user access to the first 500 of them. The reason the user is often given an approximation rather than an exact number stems from the nature of patent families.[21] If the database contains more than something in the range of 40 documents matching the search criteria, esp@cenet will first give an approximate number of hits, taking into account that there may be duplications within this set of documents and within their respective patent families. Once the user starts working their way through the result list, the number of hits will be adjusted as esp@cenet scans for those duplications and eliminates them. Usually the exact number of results will eventually turn out to be slightly lower than the initial estimated number. It is essential, however, to establish this exact number before breaking the results down by the kind of applicant to avoid double counting. This proves to be impossible when the overall number exceeds the 500 documents that will be given access to. Fortunately, this occurs only in two instances in the whole database built for this study and is denoted accordingly.

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[21] A patent family is a group of patents connected through one or several (again connected) priority documents, usually the extensions to different countries.

4.2.3.2 PatentScope

PatentScope is the WIPO's online portal for patent researchers. Apart from providing a news and document service, it also provides the user with a patent database (PCT Online File Inspection) for online searches. More than one million documents are accessible – only PCT applications and granted patents, though. This partly offsets the search mask which is superior to esp@cenet's one in terms of criteria that can be searched for. Major advantages are the search fields 'Applicant Residence', 'Applicant Nationality', 'Priority Country' and 'Designated States' as they can reveal patterns of foreign innovative activity in the Baltics – as long as these activities materialise in the form of a PCT patent application.

What limits the database is its scope. As it only gives access to PCT applications, the useful search criteria only allow for a snapshot of one aspect of patenting while others are left out. It is used, though, mainly to obtain an indication of knowledge inflows between the Baltic States and the WIPO. PatentScope is also used to double-check and verify data obtained from the other databases.

4.2.3.3 ESPACE-ACCESS

Concerning its possibilities, ESPACE-ACCESS, the only database used which is not online, but provided on DVD-Rom, is situated somewhere between esp@cenet and PatentScope. It offers a similar range of search criteria as PatentScope does, like 'Designated States' and others. Yet it covers fewer patent applications than esp@cenet, namely all European and PCT applications since 1978. Unfortunately the Baltic States appear as designated states only after their accession to the EPC, i.e. after 2002 for Estonia, 2004 for Lithuania, and 2005 for Latvia. Thus the original hope that it would be possible to trace knowledge flows through designations for EPs as well was not fulfilled. Still, the priority number proxy serves its purpose for that, so that this shortfall can be overcome with esp@net. Although ESPACE-ACCESS is limited by its inability to give patent citations[22], one can side-step this shortcoming through the database's feature to connect to esp@cenet when necessary, so that the information can be accessed there. It does not have esp@cenet's limitations in displaying results, either, making quick queries for double-checking or 'snapshots' much easier. A further advantage in comparison with the two online databases are the advanced features ESPACE-ACCESS offers when it comes to analysing the data obtained from the queries. As the database is stored and run locally, and possesses its own software interface, Mimosa 5.0, result files are generated which the user can refer to for sub-queries and further analysis at a later stage of the search process. This gives ESPACE-ACCESS a real competitive edge over the online databases, despite its limitation to European and PCT applications.

As it works hand in hand with esp@cenet, ESPACE-ACCESS is used to complement the online searches and to deepen the analysis beyond esp@cenet's limitations.

4.2.3.4 US PatFT/ US AppFT

The US online databases provide a wealth of information, yet as US patents and patent applications were not of any particular interest in this study (given its different approach to priority, classification and citations), they were hardly consulted, apart for verification of specific patent applications originating in the US. To guarantee consistency, it was usually esp@cenet that was used to track down US patent applications, as they are covered in the worldwide database as well.[23]

[22] The use of patent citations is explained below in section 4.3.3.3.
[23] A summary of the comparison of the various databases can be found Appendix A.1.

4.2.4 The Patent Database compiled for this Study

4.2.4.1 Organising the Data

Several datasets have been compiled and the results been stored in a simple spreadsheet.

The most extensive one holds roughly 4,400 patent applications, namely all documents from 1992 until November 2005 that claim priority in any of the three Baltic States, no matter in which country they were published. They are grouped by year of publication, IPC section and the 'nature' of the applicant.

To overcome esp@cenet's limitations, single queries were split up further: The main international patent classification (IPC) section of the patents was included to achieve result sizes that would not exceed 500 documents, thus raising the number of queries necessary to compile the dataset. A typical query is detailed in Appendix A.2.

For each of the generated 336 queries, the results are categorised by the 'nature' of the applicant. The main categories are: domestic (Baltic) firm (DOM), foreign firm (FOR), university (UNI), Academy of Science (AcSc), government body (GOV), individual (IND). To identify possible collaborations between the different agents in the sense of the co-operations assumed by Rugman and D'Cruz (2000), several combined categories were used: UNI/IND, UNI/DOM, UNI/FOR, DOM/IND, and FOR/IND. The category OTHER contains all remaining entities that could not be identified as belonging to any of the other classes.

Most applicants could be identified, though. The few that had to be put in the category OTHER are those where there is no information at all available. These might be former state monopolies that ceased to exist or changed their name after privatisation, firms that disappeared before roughly 1996 without any trace, applicants whose names were either misspelled or so radically abbreviated that no independent search would find them, or combinations of applicants that were either not covered by the existing categories or where at least one part was unidentifiable. Fortunately it was possible to identify most applicants so that the number of those ending as OTHERs is negligible, given that some of them again are identified but do not match any category.

The second dataset of patent applications is significantly smaller in its scope – although strictly speaking it contains more documents (roughly 23,600). It tracks down the national patent applications in the Baltics whose priorities do not lie within the same country, but in one of the major source countries of FDI, one of the Baltic neighbours, or from the 'international sphere' i.e. European or PCT patents. The countries in question were namely: Sweden, Finland, Denmark, Norway, the US, the UK, Germany, and the respective two other Baltic States in which the patent in question was not published. Again, mainly esp@cenet was used to retrieve the data, although the WIPO File Inspection and ESPACE-ACCESS were used for double-checking.

Yet another dataset looks at patent applications that have their priority in one of the three Baltic States and 'end' as an application in a major patent system of international importance, i.e. the US, the EU (EPO), or the PCT (WIPO). This – admittedly small (239 items) – group of documents has been looked at in more detail; for each item the following attributes are displayed: year of publication, nature of applicant, IPC section, additional Priority (if claimed), and identical documents from other important patent systems – in this case the respective other Baltic States, the two other patent 'spheres', and Australia[24] as fixed categories and an OTHER category. As PCT (WO) applications eventually turn into a group of national applications, a certain degree of double counting

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[24] It is interesting that quite a few of these patents is extended to Australia. One possible reason (although out with the scope of this study to be examined) is the existence of a second tier or 'petty' patent in Australia, which offers limited protection but also has lower requirements than a 'full' patent (Bommer 2001). It might be simply easier to come by.

cannot be avoided – yet is surprisingly little, and, given that the geographical spread of each document is looked at, it does not distort the general picture.

Several complementary sub-sets have been compiled to support the main dataset. One charts roughly 413,000 PCT applications from 1995 to late 2005 which are designated to either of the Baltic countries, broken down by the applicant's residence (again, only the major investing countries were taken into account). Given that when the international application is filed, any PCT contracting state can be named as a designation and only at the start of the national phase the actual designations have to be specified (and the relevant fees be paid), the picture is slightly misleading. If one compares the number of PCT applications which designate to either of the Baltic States with the number of patents granted in the respective country there is a huge difference. Another set lists all PCT applications whose applicant resides in one of the Baltic countries and lists the respective priority country, the IPC, applicant, inventor, patent number, publication date, and title. It serves mainly as a reference list once 'interesting' cases are identified, as it also provides a direct link to each document online, but is also available for further analysis.

4.3 Empirical Framework and Sequences of Analysis

Given the complexity of the development of innovative capacity in the Baltic States within the framework of both the IDP and the TDP, several approaches to the analysis are employed in the course of this study to gain as broad and comprehensive a picture of the developments within the countries with respect to their NISs as possible. This section discusses the possible uses of patent applications and describes how exactly they are used in the context of this study. The following chapters will explain the specific methods within the context of the analysis, while here the general approach is discussed and its rationale discussed.

4.3.1 'Boiling Down'

This study uses what could be termed a sequential approach to the analysis of patenting activities within and out with the Baltic States. The aim is to transform a general snapshot of these activities into a multi-faceted picture of the Baltics' TDPs that combines several methods and different angles. The focus shifts and tightens across the following chapters as well as within them, providing a kind of continuous filter, which moves from more general perspectives to very specific analyses of issues and observations made in the broader view in order to achieve the objectives laid out in the preceding chapter.

The analysis is divided into three distinct steps. Firstly, knowledge inflows from the source countries are examined with respect to their determinants; this is done by a regression analysis. In a second step, these knowledge inflows, proxied by patent applications whose priority lies out with the Baltic host countries, are put to a more detailed examination, asking questions such as: where they come from, who are the applicants, and in what technological fields are patents extended to the Baltics. In a third stage the focus of the analysis moves entirely into the host countries; it is now the generation of patent applications within the Baltic States that is the focus. Again, the patent applications are examined with respect to what knowledge (both technological field and 'value') is generated, who generates it, and whether the knowledge inflows can be linked to this domestic knowledge generation, i.e. whether the development of innovative activity in the Baltic States follows the characteristics that the knowledge inflows exhibit.

4.3.2 Regression Analysis

Before turning to the actual patenting activities in the Baltic States and what possibly influences them, the study takes one step back, so to speak, and tries to answer the question what actually brings firms (and others) from outside the Baltic rim to extend their patents to those three small countries, rather than examining the inflows themselves.[25] A casual look at the data (see the following chapters and appendices for more detail) reveals that the Baltics are not necessarily just receiving patent applications that are filed internationally 'by default', so that it is not a satisfactory explanation that those patents come to the Baltic States anyway. Neither are the Baltic States treated as an entity by the source countries, the different countries vary in their uptake of foreign knowledge.

The question the chapter seeks to answer is what exactly determines whether a patent from abroad is extended to one or more of the Baltics. Building on the theoretical considerations presented in the preceding chapter, a regression model is devised to test the influence of certain factors on the strength of knowledge inflows; these are namely the presence of FDI and/ or trade between the source and the Baltic host country, the source country's own innovative capacity, and the distance between the two countries under consideration. Following mainly Sun's (2003) study of foreign patenting in China, this study's approach adds to Sun's approach by using stronger econometric techniques, by conducting a panel data regression for all three countries over several different time periods in order to isolate the most essential determinants for foreign patenting in the Baltics.

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[25] It is not a real step back, but one back in time: before patents are extended, an incentive must be there to trigger the extension. This 'trigger' is the focal point.

4.3.3 Patenting Dynamics in the Baltic States

In the two chapters that deal with the more extensive analysis of knowledge inflows and knowledge generation similar techniques are applied, although the focus changes slightly. Accordingly, the methods used are discussed in the following part for both phases of the analysis.

4.3.3.1 Institutional Base

As explained in Chapter 3, the answer to the question who actually takes out patents in an economy is one indicator for the progress of the transition from a centrally planned to a market economy. While the large majority of industrialised, western economies display patenting patterns that rely heavily on corporate applications, with usually around three quarters or more of all patent applications being made by firms (Amesse et al. 1991). In contrast, socialist economies, and particularly the USSR, had a very large share of applications filed by individuals (usually around 80%), which served mainly to disguise government institutions where the research was carried out (Radošević 1999b, Radošević and Kutlača 1999).

Building on these observations, the institutional base of patenting activities in the Baltic States is examined both for knowledge inflows and domestic knowledge generation. As discussed in the preceding section, patent applications are categorised according to the type of applicant.

In the first phase of the analysis (which concerns knowledge inflows into the Baltic States), patent applications in each Baltic State, which claim a foreign priority (a particular source country or a PCT/ EP one), are the main focus. After looking at the absolute strength of inflows in each Baltic host country and establishing the exact sources (and their respective share of the overall inflows), the actual applicants are examined; this is done not only by category, but by identifying the applicant named in each document, together with their nationality. The nationality is important insofar as MNEs may engage in R&D in countries other than their home base but file the resulting patent applications with their parent's national patent office. Furthermore, the identification of MNEs that are extending their patent applications to the Baltic States from a range of source countries (if filings are not attributed to the parent's home country) allow for a clearer picture of the actual composition of inflows as patent streams from different source countries may actually be connected through the same applicant. This approach also helps in identifying persistent patenting from individual firms. Adopting the premises that firms that take out more patents in the host countries do more for building up available knowledge in the host countries – not just by simply adding, but by accumulating and furthering it (Breschi, Lissoni, and Malerba 1998, Patel and Pavitt 1997), persistent patenting activities should create more opportunities for spillovers to occur. Thus, by identifying those MNEs dominant in creating knowledge inflows to the Baltic States, a foundation is laid for the following examination of domestic knowledge creation.

Turning to the knowledge creation within the Baltic States, the focal point are those patent applications which claim a Baltic priority (the three countries are analysed separately). The application can be filed anywhere, although in the course of the analysis, knowledge that 'disseminates' from the Baltic States is eventually separated from those applications that remain within the countries as purely domestic applications. This is to distinguish between what Paci, Sassu, and Usai (1997) termed internationally competitive knowledge for which world- or at least Europe-wide protection is sought and domestic patent applications, which capture knowledge no less important for the country itself, but without the competitive edge. Furthermore, domestic patenting necessarily plays a rather more important role in transition economies as it usually does in advanced economies, given the former's need to catch up (da Motta e Albuquerque

2000). Knowledge creation is then also compared briefly to the inflows in order to estimate how open or attractive the Baltic economies are to knowledge inflows in relation to their own domestic efforts at patenting.

First of all, the institutional composition of applicants is examined by using the categories into which the applicants were distributed and dividing the overall time period into two shorter ones, 1992-1998 and 1999-2004. The aim of this is to see whether the institutional base of patenting in the Baltic States changes its composition over time, moving from a Soviet-era domination of individual applicants to a more western-type one, where corporate patenting is most important.

In a second step, the actual applicants are again identified by name, to examine whether it is once again possible to isolate persistent patenting activities, both by foreign and domestic actors within the Baltics. The objective is to identify, if not actual clusters of innovative activity, at least what could be termed 'pockets of activity', where a number of known applicants keep pursuing their efforts over some time. Ideally, these would consist of both foreign and domestic entities, confirming Edler's (2003) finding that MNEs do not only innovate 'on their own', but make active use of source of expertise in the host environment.

In both phases of the analysis, the applicant analysis forms the starting point. To gain deeper insight into the patenting dynamics in the Baltic States, another approach is added in both cases – that of investigating the kind of technology incorporated in the patent applications.

4.3.3.2 Revealed Technological Advantage (RTA) and Technological Profiles

One piece of information contained in the application document is that of the technological field the invention falls into.[26] The WIPO (2004, p 306) classifies patents as belonging to one or more of eight broad fields, the International Patent Classification (IPC):

> This Classification subdivides technology into 8 sections, 20 subsections, 118 classes, 624 subclasses and over 67,000 groups (of which approximately 10% are 'main groups' and the remainder are 'subgroups').

While consisting of numerous subclasses, the eight main sections are A – Human Necessities (which includes a range of medical and foodstuffs subcategories); B – Performing Operations and Transporting; C – Chemistry and Metallurgy; D – Textiles and Paper; E – Fixed Constructions; F – Mechanical Engineering, Lighting, Heating, Weapons, Blasting Engines or Pumps; G – Physics; and H – Electricity (WIPO 1971 and 2009). The classes clearly overlap, and usually a patent application indicates a multitude of classifications. However, as the document states one to two 'main classifications', these are used to establish the field into with the applications falls in this study.

This creates a methodological complication. As patent applications can claim more than one main classification – and the majority do – the question arises as to how to count them. Two methods are available, whole and fractional counts. The fractional counts approach would share the patent application in question between the classifications (two main classifications would result in the document being counted 0.5 times for the first and 0.5 times for the second). Thus the overall count would match the real number of applications. The alternative is to simply count each document once

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[26] Due to the differences between US patent law and WIPO/EPO law, some studies have tried to translate industrial sectors in which patents are made to IPC sections and vice versa (see, for instance, Sassu and Paci 1989). This would, however, be beyond the scope of this study, as virtually every single patent needs to be classified twice – for the inventor and the invention.

per classification declared (i.e. the document with two main classifications would be counted twice). Both methods have been used, although mostly when it came to more than one applicant or inventor appearing on the application. For instance, Guellec and van Pottelsberghe de la Potterie (2001) use fractional counts in their investigation of cross-border co-operation of researchers, as does Co (2002) in her study of the catching up of US regions' patenting.[27] An earlier study by Narin and Breitzman (1995), which examined patent value and inventive productivity of researchers, compared the results of both approaches when attributing patents to their inventors. They found that their findings (put simply, that very productive inventors with many patents to their name constitute only a relatively small share of the overall applicant population) did not vary greatly between the two methods employed.

As not all patent applications that are considered in this study declare main classifications (partly due to slight changes in the classification system over time, partly because of the digitalisation of documents particularly in the Baltic States), the whole counts approach is chosen to ensure continuity and consistency.

The particular interest in the technological performance of the Baltic States in comparison to their main sources of knowledge inflows stems from the assumption that the know-how incorporated in patent applications transferred to the host countries is more or less freely available[28] to those capable of utilising it, i.e. that spillovers take place.

The two chapters dealing with the patenting dynamics tackle two questions associated with this knowledge transfer: (a) Do source country firms simply extend their cutting-edge knowledge to the Baltic countries, or is the technology disclosed in the patents chosen for its appropriateness to the targeted environment; and (b) do possible appli-

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[27] Guellec and van Pottelsberghe de la Potterie focus on inventors, Co on US patent classifications.

[28] 'Freely available' in this context means strictly the availability of the published patent to any interested party. While the disclosed information can be accessed, it does not necessarily follow that it can be used: the technology gap might be too large and thus the absorptive capacity limited.

cants for patents in the Baltic States make use of the know-how from abroad in the way that they 'follow' the technological strengths the knowledge inflows exhibit?

A number of previous studies have used data on international patenting to construct indices showing the technological fields in which countries are internationally competitive. In the initial analysis that follows the broad IPC of the patent applications are used to construct RTAs for the Baltic States. RTAs are an established measure of technological specialisation of a country compared to the world average and are widely used to assess countries' (or firms') international competitiveness (Soete and Wyatt 1983, Radošević and Kutlača 1999, Co 2002, Patel and Pavitt 1997, Cantwell, Dunning and Janne 2004, Cantwell and Piscitello 2002).

The RTA of a country in a particular technological field is defined as

$$RTA = \frac{p_{ij} \Big/ \sum_j p_{ij}}{\sum_i p_{ij} \Big/ \sum_{ij} p_{ij}};$$

where p_{ij} is the number of patent applications filed in one specific patent regime (such as PCT or any national regime) in field j, claiming priority in country i. The numerator of the RTA ratio shows the proportion of a country's PCT applications in a particular technological field. The denominator represents the proportion of all PCT applications in this field. It is this measure of technological competitiveness that is used in this study in a variety of contexts to establish a detailed picture of the technological characteristics of patenting activities within and around the Baltic States.

To begin with, the technological profiles of the knowledge inflows to the Baltic States are examined in relation to the source countries' respective international patenting. For each source country, the relative strengths (and weaknesses) it exhibits in its international (PCT) patenting[29] across the eight IPC sections are established, as well as the corresponding technological profile for the distinct knowledge flows between the source country and each Baltic State. This is aimed at answering the first question outlined above. While Paci, Sassu, and Usai (1997), as well as Edler (2003) acknowledge the difference between a country's international and domestic patenting, this study asks if there are also differences between a country's general international patenting (the cutting-edge, internationally competitive knowledge) and specific host countries that patents are extended to. As described in Chapter 2, the Baltics are seen as being able to provide high-skilled and at the same time cheap labour, which should make them attractive for medium to high technology investment (which would in turn entail at least some of the patented knowledge). On the other hand, particularly Latvia and Lithuania have been struggling to transform into appealing investment environments, which has turned initial enthusiasm for international involvement (and foreign patenting) to a much more mixed view (Ghauri and Holstius 1996). Thus, comparing the source countries' overall PCT patenting with their patenting within the Baltic host countries with respect to the technology transferred may give an indication of what could be called 'tailored' approaches to the Baltic rim. This augments the picture already partly established by the analysis of the quantity of patents extended and the examination of the applicants involved in the knowledge transfer. To compare these two dimensions of pull and push factors for the extension of patents, the base of comparison is changed: As explained above, RTAs are a relative measure and computed as a particular country's performance against a base performance of all countries within a particular patent regime. In this context, source countries' PCT performance (in relation to all PCT patenting) is compared to their respective performance in each Baltic State (taking the respective Baltic State as the base patent regime). If the performance in the Baltic States

[29] For reference, the technological profiles of the countries' EP patenting are computed as well.

does not follow the international one of a source country, one could argue that specific patents are extended to the Baltics in a targeted way, rather than including the countries indiscriminately in a 'blanket' PCT application.

On the other hand, while firms from the source countries may indeed target the Baltic States with their knowledge consciously, the question arises as to why they do so. Chapter 5 provides some insights through the panel data regression, but now the analysis moves towards much more detail. Chapter 2 has outlined the advantages and disadvantages of the Baltics as hosts for FDI, yet another indicator can be the host country's RTA profile and how well it matches that of the source country *within* the Baltics. It is a broader indicator, as it ignores distinct firms' decisions, but one could argue that a firm well established in its home economy with its specific technological characteristics would find a similar country (the Baltic State in question) more attractive than an overly dissimilar one. Accordingly, the host countries' technological profiles within each Baltic State are matched with the host countries' PCT and domestic profiles both, to see how well the host and source countries match in their specific strengths and weaknesses.

This comparison of the technological patenting profiles of both host and source countries is the main feature of the analysis of the patenting dynamics around the Baltic rim and is used throughout the course of this study. While it is arguably worthwhile in itself to examine the relative technological performance of both host and source countries, it gives much more insight into the matter when one country's different performances across patent systems or different countries' performances within the same patent system are compared and evaluated.

Similar pairings of RTA profiles are used when examining the generation of knowledge within the boundaries of each Baltic States, with different reasons for possible similarities between the two sides of each pair being explored.

The second phase of the analysis tries to answer the question whether the technology brought to the Baltic States in the form of patent applications from abroad influences inventive efforts in the countries themselves, i.e. if a technology transfer takes place. Again, it is now patent applications which claim priority in the Baltic States that become the focus of the investigation. Spillovers being hard to measure directly, it is again the technological patenting profiles that are used, assuming that similarities between suspected 'inputs' (inflows or foreign activities within the host country) and 'outputs' (performance of the host country) indicate the presence of at least some kind of spillover.

A first step (after giving a general overview of the quantities and IPC distribution of patent applications originating in the Baltic States) is to distinguish between purely domestic and international patent applications. While international (PCT) applications are often seen to constitute the excellence component of a country's inventive efforts (Paci, Sassu, and Usai 1997), domestic patent applications, if not necessarily cutting-edge internationally, form an important part of a country's overall innovative activities and give an impression of the domestic demand and R&D structure and are particularly important for the study of transition economies (da Motta e Albuquerque 2000). Furthermore, countries differ in their relative emphasis of these two aspects; Edler (2003), in his analysis of the RTAs of Germany's domestic and international patenting, distinguishes between 'outward active' and 'inward active' countries, finding that countries differ in their approach to patenting. The two dimensions of Baltic patenting are compared with respect to their RTA profiles, in order to establish whether the internationally competitive share of Baltic-produced knowledge rests to some extent on domestic efforts or is entirely separate.

Furthermore, as this study is predominantly concerned with the influence that foreign knowledge and its transfer to the Baltic States has on domestic Baltic patenting, the source countries' Baltic RTA profiles (i.e. the base for the RTA is the respective Baltic patent system) are compared to both the Baltic domestic and international profiles. The assumption at this point is that the knowledge embodied in the patent applications in the Baltic States filed by foreign actors is more or less freely available within the host country. Provided the technology gap between the domestic capabilities and the published know-how in question is sufficiently small, a persistent technological profile exhibited by a source country within a Baltic State could, given some time, influence the shape the Baltic profile itself takes, as the relatively strong fields of the source country constitute a stronger transmission channel for that particular knowledge. Whether foreign knowledge is more important to the building of the purely domestic knowledge stock or in turn triggers the generation of equally advanced knowledge and thus PCT patent applications, will be examined. This is aimed at examining the Baltic States' potential for catching up with the industrialised countries, as Radošević and Kutlača (1999) have done when analysing CEE economies' US patenting.

By essentially working with one set of indicators, the RTAs, but applying these indicators to both source and host countries, across patent systems and time, and combining them with the detailed analysis of the applicants described in the preceding sections, it becomes possible to gain a very detailed, complex, and comprehensive picture of patenting activities targeted at and originating from the Baltic States since their independence. However, one more attempt is made at extricating the knowledge spillovers and accumulation in the three countries.

4.3.3.3 Patent Citations

One of the few methods of capturing the 'real' spillovers of knowledge (apart from qualitative approaches like interviews and detailed case studies) is to turn to the 'paper trail' a patent (application) leaves in its wake. Any patent application must disclose prior knowledge it rests upon in citations (Collins and Wyatt 1988, EPO 2007, WIPO 1970, Estonian Patent Office 2009, State Patent Bureau of Lithuania 1994, Patent Office of Latvia 2007), so that a 'chain' of ideas and how they follow each other becomes visible. Looking at the citations that particularly the PCT patent applications coming from the Baltic States list, it is possible to see where the prior art that the new invention is based upon originates itself. The best evidence of spillovers would be gained by pinning down this knowledge to the patents that constitute parts of the knowledge inflows anyway. However, the use of patent citations is not without pitfalls.

One major difficulty arises at the very beginning of the process of looking into patent citations. While they look like citations in an academic paper and work similarly to the extent that they identify other people's work relevant for the document in question, they often serve a different purpose and are generated differently. To begin with the latter point, most patent citations are added to the application not by the applicant, but by the examiner[30], and this in turn depends on the patent system. While the US requires applicants to disclose all prior knowledge, neither the EPO nor the WIPO ask for any inventor-added citations – although they are not forbidden, either. However, as there is no formal requirement to include them, often only the examiners are involved in finding prior art. Also, examiners have varying motivations when it comes to choosing the citations to be included: they might add those documents that might be different in kind from those the applicant has already given (provided these exist) to fill gaps in the cita-

[30] This is one reason for the 18-month period between the filing and the publication of a patent application.

tions, or they might add citations similar to those already there in order to better be able to track the evolution of the invention in questions. Thus, a publication with many citations might simply be one which has been very well searched (Hanchuk 2002). Both approaches arrive at different results when citations are approached quantitatively (Alcacer and Gittelman 2006). Meyer (2000, p 111) finds that

> … the direct influence of different groups of actors – examiners, patent attorneys, inventors – makes it difficult simply to transfer the framework for academic citation to patent citations.

Accordingly, many authors, including Jaffe, Fogarty and Banks (1998), Jaffe and Trajtenberg (1999), and Trajtenberg (1990) describe patent citations as a noisy indicator, as it is impossible to show whether the inventor is aware of any prior art contained in citations added by the examiner; however, Carpenter and Narin (1983) find citation data useful to map foreign interconnectedness of innovative efforts. Trajtenberg (1990), in his study of patent citations as an indicator of patent value and/ or impact, concludes that as long as the sample under investigation is sufficiently large, this noise can be eliminated.

Unfortunately, the sample available for the Baltic States is a fairly small one. While it is indeed interesting to have a look at the citations included in the PCT patent applications that originate in the Baltic States with respect to the amount of self-citations, and whether academic papers rather than other patents are being cited, to gain some insight into the paths of knowledge accumulation in the countries, the inherent weaknesses of the indicator combined with the small number of patents in questions make statistically robust findings impossible.

The patent citations are thus presented as more or less anecdotal evidence, which in some cases supports earlier findings and in other cases adds to the depth of understanding of innovative capacity in the three countries. The effort to map the paper trail Baltic patent applications leave is not a futile one, as it highlights connections between different actors in the system and illustrates how knowledge is accumulated and preserved in the countries. In addition, the discovery of real and possible persistent links between inventive actors or parties in the Baltic States would point to at least the emergence of structures akin to a cluster or even an innovation system – although, as demonstrated in Chapter 2, the three countries may not have advanced far enough since independence to identify a full-fledged innovation system as such.

4.4 Concluding Remarks

The aim of this chapter is to explain the methods which enable the three contributions to knowledge set out in the previous chapter to be made. It outlines the approach to follow the development of the three Baltic States towards knowledge-based economies through the use of mainly patent application and FDI data. The combination of several distinct, but ultimately related steps of the investigation is outlined, which, when taken together, will eventually create the most comprehensive picture of patenting-related development in the whole of the Baltic rim to date.

While none of the methodological approaches is entirely new in itself, their combination and interconnected use, with results complementing and augmenting each other, serve to add to existing knowledge and significantly further it with respect to innovative capacity in the three Baltic States Estonia, Latvia, and Lithuania, and their relations with their major sources of knowledge inflows.

The following chapters will now turn to the actual analysis of patenting activities in the Baltic States by using the methods outlined above.

CHAPTER 5

DETERMINANTS OF FOREIGN PATENTING IN THE BALTIC STATES

5.1 Introduction

This chapter will assess the determinants of knowledge inflows into the Baltic States using panel data analysis. Following the broad framework of the IDP, it is assumed that before the Baltic countries can develop technological strengths and an innovation base of their own (as opposed to the centrally determined profile of Soviet rule), they will need an impetus, most likely from abroad, which will then enable them to build and shape their own knowledge-based economies. Just as the IDP framework assumes an initial locational competitive edge of the host country that attracts FDI, the question arises what makes MNEs extend their own technology (in the coded form of patent applications) to the Baltic States. Yet the IDP's focus on the investment-attracting features of a developing economy must necessarily be qualified, as it is not investment but knowledge flows that are the centre of this analysis. However FDI can be understood as a bundle of benefits, which range from financial to technological to managerial aspects, thus acting as the 'catalyst' for the host countries development along the IDP and therefore an important independent variable in the model. It is one of several major factors that are identified as influencing the decision to apply for a patent in the Baltic States in this chapter.

Section 5.2 introduces the econometric model and outlines the theoretical considerations on which the model specification and choice of variables rest.

Having done that, section 5.3 presents and discusses the findings of the regressions for each Baltic State separately and assesses the appropriateness of the model specifications for the countries.

A last section summarises the findings and concludes.

5.2 Theory and Model

In the following, the model used to assess the determinants of knowledge inflows to the Baltic States is developed.

5.2.1 Theoretical Considerations

Protecting technological know-how in the host country becomes necessary when there is a perceived danger of losing it to domestic or other international competitors. In the case of domestic competitors, their ability to absorb foreign technology depends, among other things, on the technology gap between them and the source of the know-how – their potential of 'catching up'. However the necessity of protection is at least partly a sign that the MNEs in question assume this possibility to be real, especially if it is up-to-date technology that is protected.

In accordance with the theoretical framework presented in Chapter 3, the presence of FDI from a particular country will have a positive impact on knowledge flows from this country, all other things being equal. A multinational presence in the Baltic host economy will make the protection of the know-how employed in the subsidiary necessary, either to avoid imitation by competitors or to limit unwanted diffusion, if knowledge is shared with chosen suppliers or customers within a network.

It can be argued that FDI flows and the existence of trade links are factors that encourage the extension of patents to the Baltic. Trade flows serve as a proxy for the Baltic States' domestic markets' attractiveness, with higher imports to a Baltic State indicating a functioning internal market attracting foreign firms and their products. However, serving a foreign market through trade exposes a firm's products and designs in the targeted country, so to protect against imitation it is advisable to take out a patent for the product/ process made available in the host country (Sun 2003, Basberg 1983).

A source country's own innovative capabilities will to some extent determine its propensity to patent abroad. While some studies (Bosworth 1980, Schiffel and Kitti 1978) have used domestic patenting activities of a source country to measure its innovativeness, transferring knowledge across national borders involves internationally competitive innovations. The majority of authors (Sun 2003, Radošević and Kutlača 1999, Soete and Wyatt 1982, etc) argue for the use of a country's patenting in the US, in order to offset differences between national legal systems and between national 'attitudes' to patenting. In this study the number of the source countries' PCT applications is used to measure their 'output' of innovations that can compete on an international stage. As the PCT system is well established and widely accepted, it is a good proxy for innovativeness – Guellec and van Pottelsberghe da la Potterie (2001) report that their empirical results of a study of cross-border knowledge flows do not differ significantly when the US and PCT patenting are compared. Furthermore, using PCT patent applications to proxy innovativeness is consistent with this study's general preference of PCT patent applications over US ones.

This study assumes that geographical and/ or cultural proximity is vital for the successful transfer of knowledge. While several studies have confirmed the importance of proximity in facilitating knowledge spillovers (e.g. Co 2002, Sonn and Storper 2003, Kogut 2000), only Sun (2003) has treated proximity as a determinant of knowledge inflows to a country.

5.2.2 Host and Source Countries, Time Ranges, and Statistical Software

The three recipients of knowledge flows in this model are Estonia, Latvia, and Lithuania. The selection of countries where knowledge flows originate was determined by several factors. The availability of data makes the construction of a data panel possible, enabling the use of longitudinal regression models. Obviously the existence of knowledge inflows to the host countries was essential. Source countries that exhibit one or more of the following features are included in the sample: the existence of knowledge inflows, FDI, trade links, geographical proximity to the Baltic States, and strong innovative performance internationally. Naturally, the most important source countries of both FDI and patent applications, which are the focal point of this study, are included. These are the Nordic countries Sweden, Finland, Denmark and Norway as well as the other major source countries, the US, Great Britain, and Germany. To achieve an appropriate sample size as well as eliminating some bias, other countries that showed either one or more of the above mentioned features are included as well. The dataset for Estonia as a host country is the largest; it includes the source countries Sweden, Finland, Denmark, Norway, the US, the UK, Germany, France, Japan, Russia, Israel, Belgium, the Netherlands, Poland, and Switzerland. Due to the lack of data available, some source countries have to be left out of the panels for Latvia and Lithuania. In the Latvian case, these are Japan, Belgium, Israel, and Poland; while for Lithuania, only Belgium is dropped. This procedure creates its own bias in turn, as the sample of source countries is not random: The countries are chosen because of their individual characteristics regarding their involvement with the Baltic host countries or, in the case of Japan, because of the propensity to patent internationally – the only internationally dominant patenting country not to have significant knowledge flows. It also has implications for the model specification chosen, which is shown in the following section.

As for the time covered, this depends on how far the sources from which the data were obtained reach back in time. One of the main aims when assembling the datasets was to create balanced panels, thus the boundaries of the raw data were taken as the panels' boundaries as well. In the case of Estonia this limitation was the knowledge inflows, which appear only in 1995 (whether this is a limitation of the source or observed values being zero cannot be established with certainty), resulting in a data panel that covers 1995-2004. For Latvia the limiting factor is FDI data; however the panel reaches from 1994 to 2004 due to a different pattern of knowledge inflows. The Lithuanian panel is the most restricted in scope, its FDI data broken down by country only reaches back to 1997. This creates difficulties insofar as the major knowledge inflows take place before 1996 and then trail off. Therefore, regression results for Lithuania will only be reported for completeness, as they are less likely to reflect any important relationships.

As the patterns of patent inflows to Estonia and Latvia differ not only between the countries, but also show quite different developments over time (for most years a steady rise in Estonia contrasting with an early surge and subsequent fall in Latvia), the two panels have been split in to an earlier period and a later one for both countries. The Estonian dataset is split into the periods 1995-1999 and 2000-2004; while the break in the Latvian one occurs one year earlier, with the periods covering 1994-1998 and 1999-2004. This difference reflects the different lengths of the overall panels as well as the fact that foreign patenting in Latvia trails off after 1997, thus accommodating the pattern in each country. Regression results are reported for each of the shorter time periods as well as the entire panel.

The availability of panel data is fortunate. By observing the same cross-sectional units (the source countries) over time, it is possible to avoid bias due to omitted variables, as estimation approaches for panel data capture unobserved heterogeneity that are either time or unit invariant. Thus, the assumption that it is partly source countries' characteristics that determine knowledge flows to the Baltic States is explicitly taken into account by the estimation techniques applied.

To perform the estimations, the statistical package Intercooled Stata 8 is used, which offers a wide range of tools to handle panel data.

5.2.3 The Regression Model

Given the theoretical considerations, a linear regression model is developed, which broadly follows that of Sun (2003), and which takes the following form:

$$inw\_pat_{it} = \beta_0 + \beta_1 fdireal_{it} + \beta_2 importreal_{it} + \beta_3 pct\_pat_{it} + \beta_4 distance_{it} + \varepsilon_{it} \qquad (1)$$

where: inw_pat_{it} is the number of patent applications in one of the Baltic States originating in country i in time period t; $fdireal_{it}$ is the FDI flow in real terms from country i in time period t; $importreal_{it}$ denotes the imports in real terms from country i in period t; pct_pat_{it} is the number of PCT patent applications from source country i in year t; $distance_{it}$ is the geographical distance between the source and host country's capitals; and ε_{it} is the error term.

Earlier studies have used both logarithmic and linear specifications to assess international patent flows (Schiffel and Kitti 1978, Bosworth 1980), without one specification turning out to be clearly superior over the other. In this study regressions are estimated using both forms, and again the results are similar, so that the linear form has been chosen for simplicity. Sun (2003) uses cross-sectional datasets for two periods in his study of determents of foreign patenting in China by averaging data over several years and then comparing two estimations for different time periods. This study has initially followed his approach to determine the relevance of individual independent variables. Through applying stepwise regressions, it is found that controlling for population does not improve the model; likewise, the use of alternative measures of distance does not improve the model.

5.2.4 Variables and Data Sources

Following the theoretical considerations, the following variables have been identified and incorporated into the model.

5.2.4.1 Dependent Variable

Inward knowledge flows (*inw_pat*), measured by the number of patent applications filed in either Baltic host country but originating in one of the source countries, have been compiled using the EPO's online database esp@cenet. Any patent application with an application number in Estonia, Latvia, or Lithuania **and** a priority in one of the selected host countries qualifies as part of such a knowledge flow.

Although there exist significant inflows, especially to Estonia, from the international and European patent systems, these are not included for three reasons. Firstly, as most explanatory variables have a bilateral character that captures a link between host and source country, constructing corresponding variables for the international systems would prove imprecise at best. Secondly, due to the legal peculiarities of PCT patents and the automatic extension of EPs to contracting states, these kinds of patent application do not reflect 'real' inflows. They can be seen only as not aimed specifically at the Baltic States, but at one (or both) of the supranational patent systems. An extension to either Baltic State can be the result of a conscious decision on behalf of the applicant, or it may just be part of a bundle of possible extensions.[31] And thirdly, even if some of these international patent applications were to target one or more of the Baltic States directly, their origin could not be traced through the system of priority numbers applied in this study. An application of this kind would usually carry a WO or EP priority respectively and could thus not be traced all the way to its origin (unless a multi-layered priority tracing were applied). The second point is the most important, though; therefore patent applications from either international patent system are not considered at this stage of the analysis.

5.2.4.2 Independent Variables

Data on inward FDI to the three Baltic countries from the selected source countries (*fdi* and *fdireal*) were obtained from the Bank of Estonia[32], the Central Statistical Bureau of Latvia[33], and the Department of Statistics in Lithuania[34] respectively. The data is reported in nominal terms only, thus it was adjusted using GDP deflators reported by the respective national statistical offices, the base year being the earliest year in each respective panel. It proved impossible to gather all of the relevant data on each country from only one single source, given that panels stretching over reasonable lengths of time were sought. To build a panel for each country that covers a satisfactory length of time and to avoid unnecessary data manipulation, these data were left in their local currency. In this respect, each panel is consistent in itself.

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31 In the case of PCT patents, the inclusion of extension countries does not command any cost at the time of filing the application. Fees are only due when the patent reaches the national stage of the progress (is granted at the international stage), when the number of extensions drops strongly. Thus, the conscious decision to extend a patent is only made after a PCT application is recorded for this study.

32 http://www.eestipank.info

33 http://www.csb.lv

34 http://www.stat.gov.lt

Trade data, namely imports to the Baltic States (*import* and *importreal*), are provided by the UN's extensive Comtrade database on international trade.[35] The data are reported in US$ and nominal terms; again the figures were adjusted in the same way as the FDI data.

To assess the innovative strength of the source country and how it influences patenting, the respective country's number of PCT patent applications in the year in question (*pct_pat*) was recorded. As Basberg (1983) and Griliches (1990) argue, among others, the propensity to patent internationally is more comparable between countries than their respective domestic patenting. The source countries' PCT patenting is chosen for consistency. The assumption is that countries with a higher share of PCT patenting will also apply for more patents in the Baltic States; their PCT patenting activities indicating a higher overall propensity to patent abroad.

To measure the distance between host and source country (*distance*), a geographical distance matrix was created for each Baltic State that reports the distances between the capitals of the pairs of countries in kilometres. Sun (2003) has argued for the use of a country's geographical centroid as the 'anchor' for measuring distance. However, for this study the location of the capital was used for two reasons. One is straightforward: as the precise coordinates of any place are needed to compute the distance matrix, the simplest thing to do is to use the capital of a country for the measurement, as this information is easily obtained. Furthermore, in most of the countries in the analysis (with the exception of the US, Belgium, Switzerland, and to some extent Germany) the population is concentrated around the capital, making it an appropriate proxy for the distance variable. Those countries where the capital cannot be regarded as the 'population centroid' are either already so distant from the Baltic rim that defining a different point for

[35] http://comtrade.un.org/db/

measurement would change the distance only marginally (US), are small in area themselves (Belgium/ Switzerland), or have several areas in which the population is concentrated, making each choice of one single centre equally arbitrary (Germany). The geographical coordinates were collected at the respective cities' official websites and cross-checked with Google Earth. These coordinates were then converted into decimal degrees[36] and the distance matrix computed with the Geographic Distance Matrix Generator, a geographic information system.[37] An alternative measure of distance (*baltic*) was introduced to proxy the assumed clustering of countries. This dummy variable takes the value 1 if the source country in question has direct access to the Baltic Sea and 0 if it has not. An exception was made for the Russian Federation, which was given a zero, as the country's access to the Baltic Sea is almost negligible when compared to its vast area, along with the fact that the capital Moscow is considerably far from the sea as well. Preliminary regression results of the model and independent samples t tests for *baltic* and the other variables show that neither of the two distance measures is preferable to the other. Thus, *distance* was chosen as the variable for the empirical model.

Controlling for population, either through per capita measurements of both *inw_pat* and *pct_pat* or by including it in the model as an independent variable, proved unnecessary. The population variable *pop* as well as the patenting-per-capita variables *inw_pat_pop* and *pct_pat_pop* were constructed with data from Eurostat.[38] However, including either *pop* in the model or running it with per-capita variables instead of absolute ones did not affect the estimation results significantly. Therefore, in order to keep the number of variables employed to a minimum, the model specified above was used

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36 Formula for conversion:

$$DecimalDegrees = Degrees + \left(\frac{Minutes + \left(\frac{Seconds}{60} \right)}{60} \right)$$

37 Available at http://geospatial.amnh.org/open_source/gdmg/

38 http://epp.eurostat.ec.europa.eu/

throughout (see Appendix C.). The variable *pct_pat* also controls partly for population, as it is the large countries that tend to patent most in absolute numbers internationally.

5.2.5 Three Estimation Approaches

To allow for the complexity of longitudinal analyses and the resulting difficulties of this model specification, the regression equation is estimated as three separate models in order to choose the most appropriate one from their goodness-of-fit measures. The first one is a straightforward ordinary least squares (OLS) model that does not take into account specific developments over time or differences between the source countries, as all coefficients are constant across time and countries – basically t is ignored and i does not denote particular countries, but mere observations. To make full use of the availability of the panel data, a fixed effects (FE) or least squares dummy variables (LSDV) model and a random-effects (RE) model are estimated as well. While the FE model applies the OLS method again while including dummy variables for each source country (thus sacrificing degrees of freedom), the RE model is a generalised least squares (GLS) approach, which utilises a matrix-weighted average for within and between estimators, both of which will be explained in more detail below.

It is useful to further discuss the three statistical models as the discussion points to the features of the datasets. The models differ mainly in their approach to the error term ε_{it}. The error term can be thought of consisting of two elements:

$$\varepsilon_{it} = u_i + v_{it} \tag{2}$$

where: u_i is an otherwise unobserved country effect; and v_{it} , which represents any other disturbance that varies over time as well as across source countries. The v_{it} term can be understood as the 'normal' residual in the regression with the normal properties, i.e. a mean of 0, uncorrelated with itself, any explanatory variable or v, and homoskedastic (Wooldridge 2000).

The regression equation can now be re-formulated as

$$inw\_pat_{it} = \beta_0 + \beta_1 fdireal_{it} + \beta_2 importreal_{it} + \beta_3 pct\_pat_{it} + \beta_4 distance_{it} + u_i + v_{it} \quad (3)$$

Taking the OLS approach, the u_is are treated as a regressor and transformed into a constant u, which is time- and source country-invariant. OLS ignores the effects of different source countries on the relationship between dependent and explanatory variables. On the whole, however, OLS will provide comparisons with other models and help to highlight fundamental relationships.

Turning to the FE and RE models, a simplified, 'stylised' equation is employed to highlight their specific strengths and possible shortcomings for the analysis. A hypothetical two-variable case is adopted for demonstration purposes only; the reasoning behind it can be easily applied to the 'real' specification used in the analysis, as the mechanics stay the same. Assuming only one independent variable, *fdireal*, the regression model would become

$$inw\_pat_{it} = \beta_0 + \beta_1 fdireal_{it} + u_i + v_{it} \quad (4)$$

Establishing the mean value of the variable for each source country over the whole time period by assuming $\overline{inw\_pat_i} = \sum_t inw\_pat_{it} / T_i$, $\overline{fdireal_i} = \sum_t fdireal_{it} / T_i$, and $\overline{v_i} = \sum_t v_{it} / T_i$ produces

$$\overline{inw\_pat_i} = \beta_0 + \beta_1 \overline{fdireal_i} + u_i + \overline{v}_i \quad (5)$$

Subtracting the second, 'mean' equation (5) from (4) renders the country-demeaned regression equation

$$\left(inw\_pat_{it} - \overline{inw\_pat_i}\right) = \beta_1\left(fdireal_{it} - \overline{fdireal_i}\right) + \left(v_{it} - \overline{v}_i\right) \quad (6)$$

which is essentially the equation on which OLS is performed to arrive at the FE or within effects estimator (Hsiao 2003). FE takes into account changes that occur over time, rather than within countries, by producing an intercept for each country, while keeping the overall slope of the regression line constant. One conceptual weakness of the FE estimation for this particular study is the automatic removal of the variable *distance* from the model, the most obvious fixed effect, as it was explicitly included in the model. Comparisons between OLS, FE, and RE, where FE is the favoured model but the other models coefficients are in line with those of FE, will help to overcome this shortfall.

To arrive at the RE estimation, which essentially discards the OLS method in favour of a matrix-weighted average (GLS) calculation, it must be made clear what the different estimators capture. While FE concerns itself only with fixed effects within a dataset, RE captures both fixed and between effects, between effects being expressed in the time-demeaned second equation. It assumes the u_is to be random, independent, and normally distributed. However, unlike FE, these unobservable effects are subsumed under the error term, which is in turn assumed to be uncorrelated with any of the explanatory variables. Thus, for RE, both fixed and between estimators are needed. The between estimator would be a straightforward OLS estimation of (5), combining this with the within (FE) estimator (6) results in the RE estimation of

$$\left(inw\_pat_{it} - \theta\overline{inw\_pat_i}\right) = \beta_0(1-\theta) + \beta_1\left(fdireal_{it} - \theta\overline{fdireal_i}\right) + \left\{u_i(1-\theta) + \left(v_{it} - \theta\overline{v_i}\right)\right\} \quad (7)$$

where: θ is a function of σ_u^2 and σ_v^2, the squared variances of the respective error terms. If σ_u^2 assumes the value 0 (θ=0), the estimation collapses into the between estimator (5); if σ_v^2 becomes 0 (θ=1), only the within estimator or FE (6) remains (Hsiao

2003). Both RE and the between estimator rely on the strict assumption that the error term is not correlated with any of the regressors, as the presence of correlations would make it impossible to establish how much of a change in the independent variable is attributable to this correlation or to the coefficient to be estimated. This, however, makes RE vulnerable to bias, although it appears to be the most efficient model at first glance (Baltagi 2001).

It is interesting to have a closer look at the R^2s[39] that Stata reports for the different models. Chong and Gradstein (2006) use, besides the estimation results themselves, the differences between the respective R^2 of their panel regression models to test for differences between 42 countries' institutional set-ups and their effects on firms' compliance with the law. As it is partly the differences between source countries that is of interest in this study, their approach will be followed here.

For the panel regression results, Stata reports three different R^2s, based on the underlying estimators (for the sample equation again):

$$\text{within: } \widehat{\overline{\overline{inw\_pat}}}_{it} = \left(\widehat{inw\_pat}_{it} - \widehat{\overline{inw\_pat}}_{it}\right) = \widehat{\beta}_1\left(fdireal_{it} - \overline{fdireal}_{it}\right) \tag{8}$$

$$\text{between: } \widehat{\overline{inw\_pat}}_{i} = \widehat{\beta}_0 + \widehat{\beta}_1 \overline{fdireal}_{i} \tag{9}$$

$$\text{overall: } \widehat{inw\_pat}_{it} = \widehat{\beta}_0 + \widehat{\beta}_1 fdireal_{it} \tag{10}$$

While R^2 is a reliable indicator for OLS estimations' goodness of fit, it is more complex for panel data, as they do not always have all the properties one would expect from an 'ordinary' R^2 derived from OLS. Stata reports its three R^2s as the squares of correlations, assuming implicitly that they behave as if obtained by OLS. This is indeed the

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[39] $R^2 = [corr(\hat{y}; y)]^2$; $R^2 = Var(\hat{y}) / Var(y)$

case for the R^2 within when FE is run, the other two R^2s are simply correlations squared, which can be regarded as R^2s from second-round regressions. None of the three measures of R^2 corresponds directly to the RE estimates though, as this model takes into account both the between and within estimators and does not perform an OLS at all. They are still useful, as they capture those two elements of RE, while R^2 overall combines these two measures.

5.2.6 Deciding on the best Model

All three models have their merits, yet to decide which one of them fits the data best, several diagnostic tests are applied. These are: a straightforward F-test to decide between OLS and FE, a Lagrange multiplier (LM) test comparing OLS and RE, and a Hausman test (HS), which helps choose between FE and RE. Each test incorporates one model's basic assumptions on the error term as the null hypothesis and examines for the alternative hypothesis one of the other models' assumption, which naturally is contrary to that null, thus rejecting one model and choosing the other over it.

To contrast OLS and FE, the F-test's null hypothesis incorporates the assumption of OLS that there are no unobserved country-specific fixed effects, thus making the OLS model the null hypothesis itself:

$$F(n-1, N-n-k): H_0 = u_1 = u_2 = ... = u_n = 0 \tag{11}$$

where: n is the number of countries; N is the number of observations; and k is the number of regressors. u_i can be read as each country's individual intercept: while the general relationship between the independent variables and the dependent one is captured in their respective slope coefficients, a country's specific part in determining the dependent variable is captured in its individual error term. This term is constant over time for each country, resulting in what can be called a country intercept. The constants being the country dummies' coefficients in the FE regression, one can define the OLS model as the restricted model fulfilling the null hypothesis and the FE model as the unrestricted one. Thus the F test performed is

$$F = \frac{(RSS_{OLS} - RSS_{FE})/(n-1)}{RSS_{FE}/(N-n-k)} \tag{12}$$

where: RSS_{OLS} is the residual sum of squares from the restricted OLS estimation; and RSS_{FE} is the residual sum of squares from the FE model. A high test statistic argues for the presence of country-fixed effects and therefore the use of FE. It is reasonable to assume that in a sample where the source countries are not chosen randomly, but by certain criteria, country-fixed effects are indeed present, in which case the FE model will be the superior one.

The Lagrange multiplier test (Breusch and Pagan 1980, Baltagi 2001) assesses the possible superiority of RE over OLS, setting the null hypothesis as $H_0 : \sigma_u^2 = 0$, and again making OLS practically the 'null model'. The test postulates that

$$LM = \frac{NT}{2(T-1)}\left[1 - \frac{v'(I_N \otimes J_T)v}{v'v}\right]^2 \tag{13}$$

where: I_N is an identity matrix of the dimension N; J_T is the identity matrix for the dimension T; and ⊗ expresses the Kronecker product.[40] The test statistic follows a χ^2 distribution for the RE estimation results. A large value suggests the RE model to be more appropriate for capturing unobserved country effects than a straightforward OLS estimation.

[40] The Kronecker product is the tensor product of two matrices of arbitrary size, resulting in a block matrix (Horn and Johnson 1991).

As the RE model returns unbiased estimation results only if the condition that u_i is uncorrelated to the regressors is satisfied, this assumption is used as the null hypothesis for the model specification test developed by Hausman (1978). It compares an estimator known to be consistent (FE) with the specification that is efficient under the null hypothesis (RE). The test is based on the Wald criterion, stating as H_0 that the differences between the coefficients resulting from the RE and FE estimations are not systematic.

$$HS : \chi^2(k) = (\beta - \mathrm{B})' \left(Var_\beta - Var_\mathrm{B}\right)^{-1} (\beta - \mathrm{B}) \tag{14}$$

where: β and B are the estimated coefficients of the FE and the RE model respectively; Var is the variance-covariance matrix and k is again the number of regressors. As before, a high value for χ^2 argues for the use of the FE model.

It has to be noted, though, that the very design of the datasets argues for the FE model to be applied. As this study explicitly assumes that it is the characteristics of the source countries of knowledge that determines technology transfers to the Baltic, and as these particular characteristics are relatively fixed over a time like that under consideration, the FE model seems justified from a theoretical standpoint. Furthermore, the sample of source countries is not random – they were chosen for their involvement with the Baltic host countries and partly to offset possible bias. As one of the most interesting variables, *distance*, is dropped in the FE model to become part of the country intercept, the other two models are run to compare the coefficient for distance – when that is feasible, i.e. when the coefficients are similar across the models. Furthermore, while the construction of the dataset points to FE, it is not necessarily the 'best' model by default.

5.3 Results and Discussion

5.3.1 Estonia

The regression results for Estonia as the host economy are reported in Table 5.1 for the entire period 1995-2004, in Table 5.2 for the earlier sub-sample 1995-1999, and in Table 5.3 for the later sub-sample 2000-2004.

As a Breusch-Pagan test[41] revealed heteroskedasticity for the data set, the regression was run with robust standard errors, which makes estimations possible for samples that do not correctly mirror the overall, unknown population, due to the presence of outliers or when underlying parametric assumptions are not quite correct.

Table 5.1: Regression results for Estonia, 1995-2004

Dependent Variable:
Patent Applications in Estonia originating elsewhere (inw_pat)

Independent Variable	OLS	FE	RE
fdireal	1.52E-05	6.37E-06	1.14E-05
	(2.75)***	(1.47)	(2.99)***
importreal	7.22E-09	1.29E-07	1.98E-08
	(0.55)	(2.93)***	(1.20)
pct_pat	5.40E-03	5.34E-03	5.41E-03
	(6.53)***	(9.56)***	(14.76)***
distance	-6.63E-03	(dropped)	-6.61E-03
	(-4.14)***		(-3.98)***
constant	12.92771		
	(4.75)***		
N	139	139	139
R^2	0.7569	0.6457	0.7544
F/Wald	19.96***	39.22***	284.00***
Type of test	F	LM	HS
Test Statistic	2.97***	5.02**	18.78***

*Figures in parantheses are t/χ statistics (two-tailed); *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively*

41 The Breusch-Pagan test for heteroskedasticity tests whether the estimated variance of the residuals from the regression are dependent on the values of the independent variables. The squared OLS residuals are regressed on the explanatory variables in the model. The test statistic (a simple LM test performed for this second regression) shows a χ^2 distribution, and a high test statistic points to the presence of heteroskedasticity in the data (Wooldridge 2000).

In both panel data models the coefficients are jointly significant at the 1% level. As expected, the coefficients for *fdireal*, *importreal*, and *pct_pat* are positive and mostly significant, while the coefficient for the variable *distance* is negative and significant. Naturally, *distance* is dropped in the FE model, as distance is a fixed effect itself, varying across source countries but not over time. The three tests applied to determine the most appropriate model point jointly to FE, unfortunately arguing for the abandonment of *distance* in the course of the analysis.

However, as the coefficients are generally consistent over the three models, it seems reasonable to assume that distance has indeed an inverse effect on foreign patenting in Estonia, all other factors being equal: Countries in close geographical proximity to Estonia are more likely to apply for Estonian patents.

One observation is that while in the FE estimator *importreal* is significant, it is *fdireal* that is significant in the two other models and vice versa. This may be due to a shift of the variables' importance for knowledge inflows over time, an effect that is analysed by splitting the panel into two shorter time periods below. It is also possible that FDI is source country-specific and thus captures differences between the countries; or at least more so than trade flows do. Should this be the case, it is logical that FDI, being a 'half-fixed effect' in a way, becomes insignificant in the FE estimation, where country dummies capture the heterogeneity of source countries. On the other hand, the two variables FDI and trade are correlated (the correlation coefficient being 0.5014), which also accounts for the shift of significance between the models.

The source countries' propensity to file patents internationally (*pct_pat*) has a quite strong impact on their respective likelihood to also file patents in Estonia, its coefficient being significant at the 1% level in all three estimators. This is not surprising, as one would expect a country whose innovations are internationally competitive to also extend this know-how to new markets. However, a persisting problem of transition economies in general and of ex-Soviet ones in particular has been legal insecurity, especially in the early period of transition, thus making the strong significance somewhat surprising. On the other hand, Estonia joined the WIPO as early as 1994, with the data covering 1995 onwards; this may be an expression of relatively early confidence in protecting intellectual property there. These findings hold true in the estimation for the earlier time period, reported below.

Table 5.2: Regression results for Estonia, 1995-1999

Dependent Variable:
Patent Applications in Estonia originating elsewhere (inw_pat)

Independent Variable	OLS	FE	RE
fdireal	1.29E-05	1.12E-05	1.49E-05
	(3.1)***	(2.75)***	(3.32)***
importreal	1.96E-08	6.97E-08	1.79E-08
	(1.73)*	(1.12)	(1.48)
pct_pat	5.05E-02	1.18E-02	5.26E-03
	(11.25)***	(10.06)***	(11.06)***
distance	-4.08E-03	(dropped)	-4.45E-03
	(-3.36)***		(-3.45)***
constant	-4.288569		
	(-0.77)		
N	65	65	65
R^2	0.7898	0.6423	0.7421
F/ Wald	43.17***	56.21***	172.66***
Type of test	F	LM	HS
Test Statistic	5.26***	0.05	30.80***

*Figures in parantheses are t/z statistics (two-tailed); *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively*

Table 5.2 shows that the coefficients exhibit the expected signs. Furthermore, FDI is significant at the 1% level in all three models during this earlier period of transformation. RE mirrors the results of OLS closely, with the respective t/z test statistics being similar, too. In all models, the estimated coefficients are jointly significant at the 1% level. Similarly, the diagnostic tests suggest that the FE model is the most appropriate one for the first period of Estonia's transition process. Yet, with the only exception of *importreal* in the OLS model, all coefficients do not only have the same signs, but are also strongly significant over all three models. This suggests that, consistent with the theoretical assumptions, the presence of FDI in Estonia indeed has an influence on MNEs' patenting activities in the country in that time period. Furthermore, in this earlier time period, it is indeed the presence of FDI in Estonia that has an impact on knowledge inflows, implying that the extension of patents to the country is preferred when tied to actual investment rather than arms-length trade. Moreover, the fact that *distance* also exhibits the expected negative sign implies that firms from source countries nearer to Estonia are more prone to extend their knowledge to the host country. Although it is well established that proximity indeed fosters knowledge transfers, it seems reasonable to interpret the results as a sign that when it comes to foreign patenting in Estonia, a 'hands-on' position in the country is indeed beneficial or encouraging for deeper involvement. Overall, during the years 1995-1999 as well as over the whole time under analysis, Estonia proves to be a fairly attractive economy for foreign firms with respect to the extension of existing technology.

The picture becomes more complicated when the models are estimated for the second time period, 2000-2004, reported in Table 5.3 below.

Table 5.3: Regression results for Estonia, 2000-2004

Dependent Variable:
Patent Applications in Estonia originating elsewhere (inw_pat)

Independent Variable	OLS	FE	RE
fdireal	1.51E-05	-1.02E-05	6.35E-06
	(1.65)	(-1.35)	(1.99)
importreal	-5.44E-09	1.87E-07	2.78E-08
	(-0.17)	(2.58)**	(0.85)
pct_pat	5.72E-03	1.97E-03	5.53E-03
	(5.46)***	(0.99)	(8.85)***
distance	-9.68E-03	(dropped)	-9.12E-03
	(-4.29)***		(-2.77)***
constant	20.03754		
	(4.46)***		
N	74	74	74
R^2	0.7643	0.3559	0.7552
F/ Wald	11.17***	3.04**	109.99***
Type of test	F	LM	HS
Test Statistic	3.44***	2.47	18.38***

*Figures in parantheses are t/z statistics (two-tailed); *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively*

As before, the test results point to the FE model as the 'best' one, despite its low overall R^2 value. However, the coefficients' signs vary wildly over the models, with the coefficients for FDI and imports changing from negative to positive and vice versa. It is interesting to note that the RE model seems to be most consistent with both the results of the earlier period and those of the full-length panel. However in this case, the direct comparison with each of the other two models favours OLS in the LM and FE in the HS tests respectively – RE is universally inferior. To explain these striking discrepancies, a closer look is taken at the three R^2 values Stata reports for the longitudinal regression models in each time period, and which are presented in Table 5.4 below.

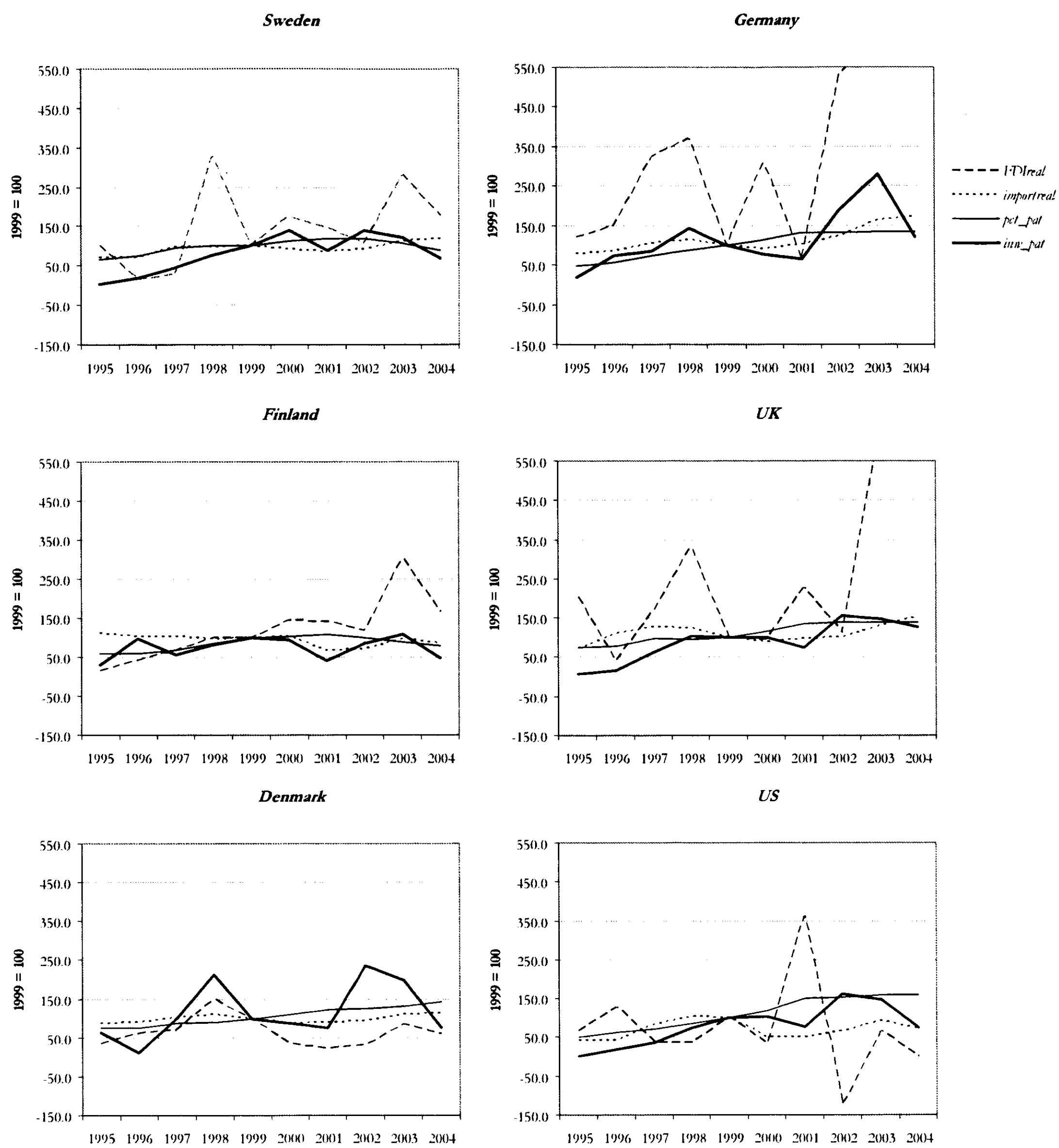
Table 5.4: R^2 of estimation results for Estonia

time range	R^2	OLS	FE	RE
	within		0.4930	0.4610
1995-2004	between		0.7616	0.9176
	overall	0.7569	0.6457	0.7544
	within		0.7820	0.6828
1995-1999	between		0.8210	0.9308
	overall	0.7421	0.6423	0.7421
	within		0.1401	0.0330
2000-2004	between		0.3959	0.8873
	overall	0.7643	0.3559	0.7552

While all measures of R^2 are reasonably high for both FE and RE in the first time period, the R^2s, particularly those for within groups, drop dramatically in the second time period. The within groups R^2 accounts for the model's explanation of variation within the groups (deviations from group means over time), i.e. the changes of relationships that occur within the data for any one single source country. R^2 between groups accounts for the variation that occurs across the population of source countries (variation of group means) (Hsiao 2003). Thus, for 2000-2004, the RE model, although with a bias, captures a significant share of the differences between the source countries, while it almost completely fails to account for variation within the single source countries. It is therefore more similar to OLS overall, as OLS does not account for groups at all. For the favoured FE model, all three measures of R^2 fall sharply in the second period, which is to some extent surprising, as it shows a good fit for both the earlier time period and the overall panel. It is precisely this relatively good fit for the two other time periods that argues for a deeper examination of its failure to accurately explain variations in patenting in 2000-2004. Therefore, a closer look is taken at the underlying data, and the FE model is fitted again to obtain coefficients for the separate source countries as well.

Figure 5.1 shows the variation over time in variables included in the model for the most important source countries. To maximise comparability, all variables are indexed, with 1999, the last year of the earlier time period, set as the base year.

Figure 5.1: Regression variables for selected source countries (host country: Estonia)



It is interesting to note how much the three Nordic countries' patterns differ from those of the three other source countries Germany, the United Kingdom, and the US. Of the six, the picture for Finland is the least volatile one: all variables showing roughly similar trends, with the slight exception of the smoother line of Finnish PCT patent applications. In the case of FDI, this is not overly surprising, as FDI flows are naturally volatile, given their project-based nature. Finland is also one of the few source countries whose PCT patenting is not strongly correlated with patent extensions to Estonia; another one is Denmark. Danish PCT applications, on the other hand exhibit a steady rise, with the trend in Danish patent applications in Estonia being most similar to FDI inflows. FDI flows from the three 'non-Nordic' source countries vary wildly in strength, the values for Germany and Great Britain peaking at over 600% and 900% of their 1999 level respectively and with even divestment from the US in 2002. These differences in the countries' patterns explain partly the higher R^2 for the between groups estimator over the within estimator – the countries are indeed probably more varied in their individual patterns than 'within themselves' over time. Looking at the later time period, the fall in R^2s can also be understood more clearly. Apart from a surge in Swedish FDI in 1998, the overall patterns are generally more 'in sync' before 1999 than after. This is confirmed by the observation that most correlations between independent variables and patenting in Estonia are weaker in the second period or even reverse. The development of knowledge inflows is most similar to that of the source countries' PCT patenting, with PCT patenting resembling almost a trend line of patent applications in Estonia; PCT patenting and patenting in Estonia, though, are quite strongly correlated in most cases, partly because they also capture population. FDI inflows show the greatest disparity between Nordic and other source countries, although independent samples t tests do not confirm a systematic difference. While they are very volatile, partly due to the privatisations and infrastructure projects in Estonia, in the Nordic countries' case, they are roughly mirrored by the patent inflows, although with lags. This again suggests source country-specific characteristics as factors that determine knowledge inflows at least to some extent.

These findings are surprising insofar as one would naturally expect the earlier period of transition to be the more turbulent one, in which relationships between knowledge inflows and other phenomena is less clear-cut than later, when the economy has stabilised. A possible explanation is that, while in Estonia's early transition MNEs had to create their own 'fertile ground' for innovation, knowledge inflows become more disconnected from the other factors. During this early period, the country was more dependent on an impetus from abroad to start the development of its own institutional and regulatory structures to support sustained innovative activities. In the later years, when this environment has formed, the relationships become less pronounced. A critical mass of inflows is achieved that disconnects these knowledge inflows from the initial inputs (captured by the independent variables) needed to facilitate the foreign patenting in Estonia. Foreign patenting activities become more independent, probably coming through links already established and formalised in the early phase, thus creating possible lags or other determinants not captured by the model. However, due to the availability of data, the relative shortness of the time period under investigation, and the early stage of transition, no lags were incorporated in the model.

5.3.2 Latvia

As with Estonia, the estimation results for Latvia as the target country are presented for three time periods separately: overall (1994-2004, Table 5.5), an earlier period (1994-1998, Table 5.6) and a later period (1999-2004, Table 5.7).

Table 5.5: Regression results for Latvia, 1994-2004

Dependent Variable:
Patent Applications in Latvia originating elsewhere (inw_pat)

Independent Variable	OLS	FE	RE
fdireal	2.66E-04	-1.15E-04	2.36E-04
	(1.58)	(-0.69)	(1.10)
importreal	5.61E-08	-1.44E-07	5.19E-08
	(2.42)**	(-4.28)***	(2.22)**
pct_pat	-1.46E-03	-2.80E-03	-1.62E-03
	(-2.65)***	(-8.18)***	(-3.87)***
distance	1.52E-02	(dropped)	1.59E-02
	(3.78)***		(6.60)***
constant	-10.13968		
	(-1.93)*		
N	121	121	121
R^2	0.3679	0.0828	0.3360
F/ Wald	8.14***	34.28***	62.33***
Type of test	F	LM	HS
Test Statistic	12.07***	18.70***	62.32***

*Figures in parantheses are t/z statistics (two-tailed); *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively*

FDI is not significant in either model, which is interesting, as particularly R&D activities are often associated with FDI. Trade, on the other hand, is significant throughout, as traded goods often need patent protection in the host country as well. This may point to Latvia as a target for mainly passive knowledge, which is merely exploited in the country rather than serving as a basis for further innovation; or possibly it is the trade-centred version of the IDP (Dunning, Kim, and Lin 2001) that is more relevant for the county's situation. It is possible that, while the Estonian government opened the country radically to foreign investment and associated knowledge inflows, Latvia is still relying more strongly on its perceived inherited strengths. The following chapters will discuss this contrasting development in more depth. On the other hand, the results are relatively inconsistent over the three models, the exception being the coefficient for distance, which is positive, contrary to expectations. As Japan as a source country and the world's second largest source of PCT patent applications had to be dropped from the dataset, the relative weight of the US is probably causing this reversal of the coefficient's sign. FE is not surprisingly the favoured model again, mainly due to the fact that the sample of source countries is not random, while all R^2s are low, especially the one for FE.

Part of the explanation for this inconsistency may lie in the pattern of the knowledge inflows over time. Far more than in Estonia's case, the two shorter time periods differ greatly with respect to knowledge inflows. While in the earlier period 1994-1998 the number of patent applications in Latvia experiences a surge, the activities fall sharply from 1997 onwards and level off in later years. This development is discussed in more detail in the following chapter. Furthermore, the number of applications originating outside Latvia never reaches the levels in Estonia, making the estimation of the influence of the independent variables more difficult and the results less pronounced.

Table 5.6: Regression results for Latvia, 1994-1998

Dependent Variable:
Patent Applications in Latvia originating elsewhere (inw_pat)

Independent Variable	OLS	FE	RE
fdireal	-8.75E-05	-5.87E-05	-9.91E-05
	(-0.27)	(-0.18)	(-0.25)
importreal	2.63E-08	-2.83E-07	2.83E-08
	(0.50)	(-2.57)**	(0.54)
pct_pat	3.11E-03	-3.44E-03	1.46E-03
	(0.84)	(-1.98)*	(0.84)
distance	3.10E-03	(dropped)	7.72E-03
	(0.37)		(1.37)
constant	8.528993		
	(1.02)		
N	55	55	55
R^2	0.4546	0.1591	0.4413
F/ Wald	2.98**	5.38***	26.36***
Type of test	F	LM	HS
Test Statistic	6.04***	0.81	(-577.08)

*Figures in parantheses are t statistics (two-tailed); *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively*

The results, shown in Table 5.6 for the earlier period, are surprising at best. Apart from the differences between the models, where FE exhibits opposite signs for most of the coefficients, contrary to expectations distance from Latvia seems to have a positive effect on the propensity to apply for patents in the country, which is contrary to the expectations. The same is true for the influence that the amount of FDI has on patenting activities in Latvia: here the coefficient is negative in all models, albeit not significantly so. Furthermore, only the coefficient for imports is significant at the 5% level under FE (and *pct_pat* at 10%), all other results bearing no significance at all. The tests favour FE again; however R^2 is quite low for all models.

One explanation could be the shape of the *inw_pat* curve in 1994-1998, which is analysed in the following chapter, when knowledge inflows themselves are examined: it is more or less bell-shaped, suggesting a non-linear relationship with at least some of the variables. Distance could be positive because of the US's weight without Japan in the dataset, which had to be dropped because of missing data. However, there is a strong involvement between Latvia and the US, while Estonia is more deeply connected with the surrounding countries, so the positive coefficient could indeed mirror this relationship. It also seems to confirm the findings of Javorcik, Saggi and Spatareanu (2004), who in their study of technology spillovers in Romania found that these spillovers increase with distance, as more inputs need to be sourced in the host country, facilitating stronger networks between MNE subsidiary and its local suppliers.

The Hausman test statistic is negative in this case, which is surprising at first sight, but happens relatively frequently for small samples. Rather than assuming that a negative value is a very small value and choosing the RE estimator, the value points to the fact that neither specification captures appropriately the relationships between the independent variables and patent inflows into Latvia. As the Hausman test assesses whether the differences between the two models' coefficients are systematic, comparing two poorly specified models will not return a clear-cut preference for one model or the other. The fact that only two coefficients in the FE model are significant and none under RE, points to the same conclusion.

Table 5.7: Regression results for Latvia, 1999-2004

Dependent Variable:
Patent Applications in Latvia originating elsewhere (inw_pat)

Independent Variable	OLS	FE	RE
fdireal	1.49E-04	4.37E-05	1.39E-04
	(2.16)**	(0.91)	(2.37)**
importreal	2.91E-08	4.61E-09	3.32E-08
	(2.34)**	(0.49)	(4.03)***
pct_pat	-3.67E-04	-1.40E-03	-7.20E-04
	(-0.98)	(-8.90)***	(-4.24)***
distance	7.19E-03	(dropped)	9.43E-03
	(2.54)**		(7.75)***
constant	-8.568883		
	(-2.40)**		
N	66	66	66
R^2	0.8100	0.6782	0.7878
F/ Wald	11.35***	27.22***	132.89***
Type of test	F	LM	HS
Test Statistic	9.52***	2.78	36.39***

*Figures in parantheses are t statistics (two-tailed); *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively*

As Table 5.7 shows, in the later time period, the estimation results become considerably more consistent. The coefficients are consistent over the three models, although they do not all confirm the assumptions made about their positive or negative impact of variables. And whereas all coefficients are significant under RE and all but *pct_pat* are under OLS, only *pct_pat* is significant at the 1% level under FE, which the tests point to as the most appropriate specification. In the two discarded models, the amounts of FDI and trade into Latvia do indeed seem to have a positive influence on filing of patent applications in the host country, thus corresponding with the assumptions made earlier about the level of economic involvement facilitating the extension of technological know-how. However, this is not the case for the FE model. On the other hand, both the propensity to file PCT patent applications and the geographical proximity to Latvia obviously deter knowledge flows rather than encourage them. This is interesting, but can at least with respect to distance be explained by the fact that Latvia is less intensively interwoven with one of its immediate neighbours, while Estonia in contrast has a high level of direct involvement with Finland, for instance.[42] As for PCT patenting activity, this might be regarded as an indirect expression of the size of the technology gap between Latvia and its sources of technology. Possibly foreign firms do not expect to find the fertile ground for their technology (or competition from indigenous competitors) in Latvia than they encounter in Estonia. A look at the 'inflows' that Latvia receives from the PCT and European patent systems (as reported in Appendix B.1) lends support to this interpretation: Latvia receives between a seventh and a third of the number of PCT applications extended to Estonia, and hardly any EP applications. Although this cannot be regarded as hard evidence due to the mentioned weaknesses of this measure of inflows, it cannot be completely ruled out as an explanation either. The negative coefficient of PCT patenting can also be explained by the pattern of the underlying data itself, reported in Figure 5.2:

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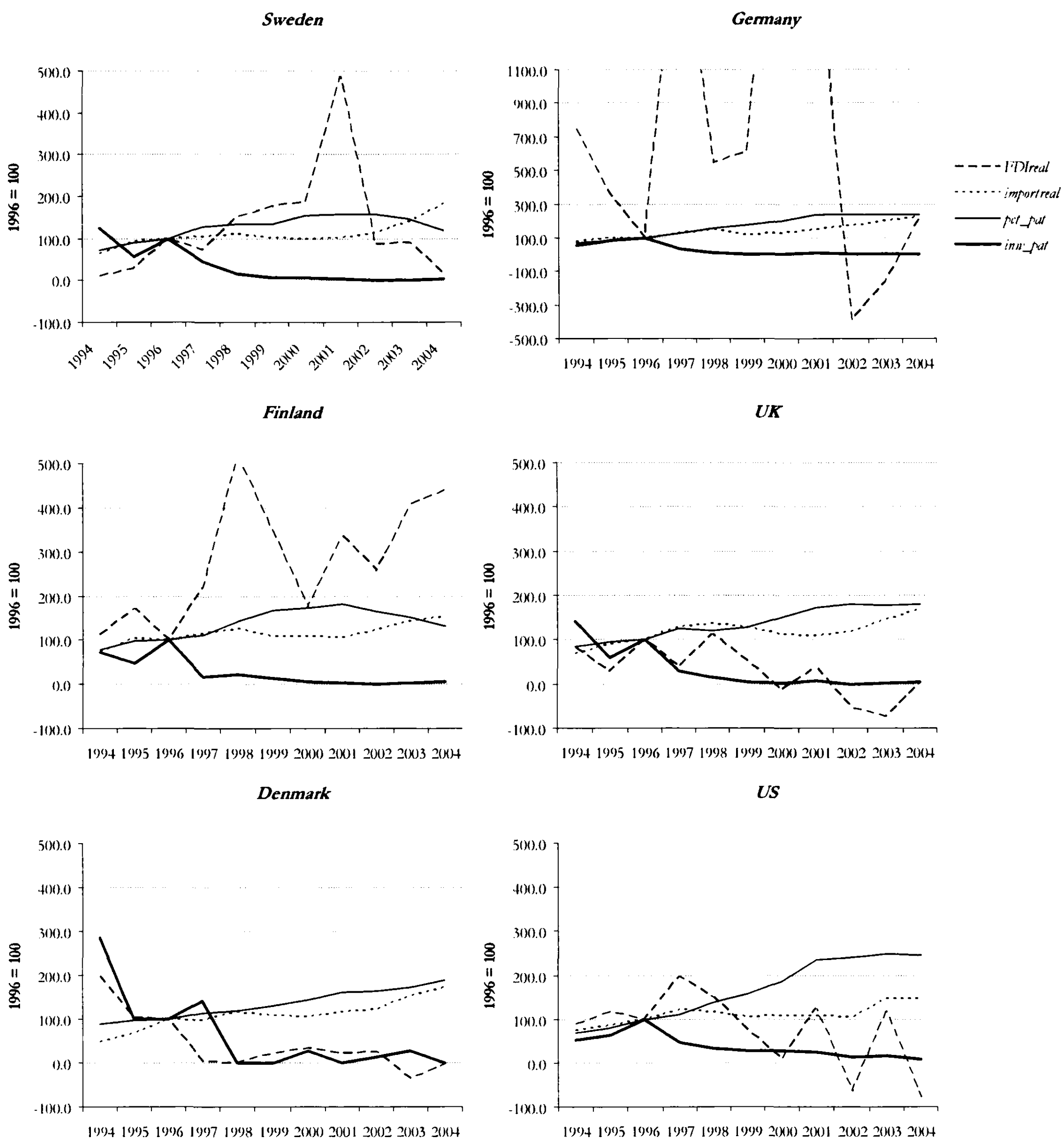
[42] See Chapter 2..

Figure 5.2: Variables for selected source countries (host country: Latvia)



While patenting in Latvia trails off in later years, numbers of PCT patent applications from all source countries experience a steady rise. On the other hand, FDI flows exhibit a less than consistent pattern for different source countries, with those from Denmark, the UK, and the US falling simultaneously with the knowledge inflows, while FDI from Finland and Sweden (and partly Germany) follows an almost opposite pattern and seems to be sparked by privatisations in the country. It can be argued that FDI that is aimed at these privatisations does not necessarily provide such a strong impetus for technology transfer as 'normal' FDI would, because existing organisations are accommodated by the investing firm and for the first time after the acquisition restructuring dominates the management, rather than expansion through innovativeness (Anand and Kogut 1997).

Despite the obvious poor fit that the specified regression model poses in the Latvian case, it is worthwhile to examine the different measures of R^2, reported in Table 5.8.

Table 5.8: R^2 of estimation results for Latvia

time range	R^2	OLS	FE	RE
	within		0.4901	0.2369
1994-2004	between		0.8292	0.5788
	overall	0.3679	0.0828	0.3660
	within		0.2823	0.1971
1994-1998	between		0.3865	0.7038
	overall	0.4546	0.1591	0.4413
	within		0.6109	0.3896
1999-2004	between		0.9643	0.8743
	overall	0.8100	0.6782	0.7878

Accepting that the model obviously does not capture the development in the earlier time period well, still some interesting observations can be made for the later one as well as for the whole time under investigation. Consistent with the case in Estonia, the model seemingly captures variations between source countries better than within them. This is especially striking for the combined time periods, where R^2 between groups is quite high at 0.8292 despite a very low overall R^2 of only 0.0828 for the overall FE estimation. The R^2 between groups is also highest for the period 1999-2004, coinciding with the highest overall R^2s for all three specifications. This finding is encouraging insofar, as it suggests that the characteristics of the respective source countries do indeed matter when it comes to the decision whether to make technology available in the Baltic host country, and not simply the attractiveness of the targeted country with all other things being equal.

5.3.3 Lithuania

The estimation results for Lithuania are merely reported for completeness in this chapter, as this study is concerned with all three Baltic States. However, due to the limited scope of the Lithuanian dataset, no meaningful results are expected.

Table 5.9: Regression results for Lithuania, 1997-2004

Dependent Variable:
Patent Applications in Lithuania originating elsewhere (inw_pat)

Independent Variable	OLS	FE	RE
fdireal	1.17E-08	3.28E-09	9.89E-09
	(1.90)*	(0.77)	(1.44)
importreal	1.40E-09	-1.51E-09	8.24E-10
	(2.12)**	(-1.32)	(0.78)
pct_pat	4.32E-04	-3.49E-04	2.25E-04
	(5.08)***	(-5.13)***	(3.52)***
distance	8.48E-05	(dropped)	6.32E-04
	(0.31)		(2.09)**
constant	-0.1677696		
	(-0.35)		
N	109	109	109
R^2	0.6338	0.6134	0.5761
F/ Wald	15.28***	10.75***	44.63***
Type of test	F	LM	HS
Test Statistic	16.13***	2.11	540.17***

*Figures in parantheses are t/z statistics (two-tailed); *, **, and *** indicate significance at the 10%, 5%, and 1% level respectively*

Not surprisingly, the coefficients are neither consistent nor equally significant over the three models. FE, the favoured model, shows coefficients that, just as with Latvia, are contrary to the expectations. The only result that is significant (and at the 1% level) in all three models is *pct_pat*, unfortunately having different signs.

It would be interesting to fit the model to a longer time period, given that on the one hand the knowledge flows to Lithuania are strongest in the time immediately after independence, the country showing a similar pattern of knowledge inflows as Latvia. However, there are no data on FDI available prior to 1997, leaving the findings for Lithuania limited.

The various values R^2 are reported in Table 5.10 below.

Table 5.10: R^2 of estimation results for Lithuania

time range	R^2	OLS	FE	RE
	within		0.2596	0.1586
1997-2004	between		0.9345	0.7862
	overall	0.6338	0.6134	0.5762

As with the other two Baltic States, R^2 is strongest for between group variations captured by the FE model, implying that despite its shortcomings, the model still captures the fact that there are differences between the source countries with respect to knowledge inflows.

5.4 Conclusions

This chapter seeks to explain what influences foreign companies' decision to extend their technological know-how to Estonia, Latvia, and Lithuania. It is assumed that a combination of locational attractiveness of the Baltic States (geographical proximity and trade), involvement in the host country (FDI), and the innovative capacity of the source country itself (the propensity to patent internationally) determine whether and how much knowledge flows from the respective source country to either Baltic country. A linear regression model is fitted to test for the influence of this combination of 'pull' and 'push' factors, using panel data for each Baltic State.

In the case of Estonia, the model partly confirms the predictions, with especially geographical proximity and economic involvement inducing the transfer of knowledge to the host country. This also confirms the assumption that it matters indeed who transfers this technology by pointing to partly unobserved source country-specific factors playing a role in facilitating the extension of patents to Estonia. The picture is less clear for Latvia, where it seems that the farther away the source country is, the more likely it is to transfer knowledge to Latvia. At a second glance, Latvia's traditionally strong involvement with the US makes this less surprising; still it is interesting to note that maybe Latvia does not fall in the country cluster around the Baltic Sea as smoothly as its neighbour does. Knowledge inflows to Lithuania and what factors facilitate them cannot be accurately captured with the model, mainly due to a lack of data for the early period of transition.

As the models consider knowledge inflows, it cannot be established at this point whether the investing firms merely exploit their own technology in Estonia, or whether they expect their know-how to fall on fertile ground, hoping for synergies by transferring it. The following chapters will investigate the actual patenting dynamics in the Baltic States in more detail.

CHAPTER 6

KNOWLEDGE INFLOWS INTO THE BALTIC STATES

6.1 Introduction

According to the theoretical framework presented, the 'opening up' of an economy to FDI and trade can alter a country's development path. Alterations, or upgrading, in the words of Dunning, occur not only though enhanced productive capacity but also through increased innovative capacity.

The previous chapter examined the determinants of foreign patenting within the Baltics and found that the reasons why patents from foreign countries are extended to the Baltic States differ for each host country. A closer analysis of these inflows will therefore shed more light on to what knowledge is attracted, from where, and from what type of applicant. Accordingly, this chapter will provide an insight into the knowledge flows themselves; rather than assessing the determinants, it will focus on the patents extended to the Baltic host countries: Who is it that patents, what knowledge is codified in those patents, and what technological profiles do source countries develop within the Baltic States, as opposed to their internationally competitive patenting activities? This way, while sticking to the original reasoning of the IDP, it is intangible assets, namely the knowledge incorporated in patent applications, that forms the centre of the analysis.

Thus the analytical focus shifts from a purely quantitative to a more mixed approach, taking into account both the absolute and relative strengths of the knowledge inflows, as well as their composition, origin, institutional source, and technological nature, which in turn reflects the technological strengths and weaknesses of the source countries themselves. In this way, a detailed assessment of the knowledge that is extended to the Baltic host countries is achieved, allowing for a comparison of the source countries and an examination of their impact on the transition economies. The chapter is organised in the following way:

Section 6.2 defines the overall focus: To remain consistent with the approach of continuously narrowing down the spotlight of the analysis to the most relevant and important findings, the number of source countries is reduced to allow for a deeper and more thorough examination of knowledge inflows.

Having done that, the following section looks at the inflows in general terms: their absolute volume, their composition by the selected source countries, and how they develop over time.

In section 6.4, the knowledge inflows to each of the Baltic States are examined with respect to their composition. Their institutional base is documented, followed by the identification of major sources of this knowledge. Applicants that either account for a large share of patent applications in the Baltics or that apply for patents repeatedly and persistently are identified. This makes it possible to pinpoint sources of knowledge not only with respect to their geographical but indeed their institutional origin, and thus isolate very targeted, specific knowledge flows. This is important to assess the structural make-up of patenting activity in the Baltic States by foreign actors, emphasising the importance of persistent patenting for building the basis for catching up (Radošević 1999a).

With the applicants identified, the following section then deals with the kind of knowledge transferred, i.e. the technological field that the specific patent applications fall into. Assuming that knowledge from out with the Baltic rim can 'kick-start' or aid the subsequent knowledge generation within the host economies (provided there is sufficient absorptive capacity), it is vital to know *what* knowledge flows there are in the first place. By breaking the patent applications down into eight broad technological fields, an initial overview is given of the areas in which most applications are filed. Yet in order to see where the knowledge flows are concentrated, the relative measure of Revealed Technological Advantage (RTA) is applied. The relative technological specialisations of applications from each source country within each Baltic State are charted and compared to both the source country's and the host country's international profile in order to establish whether the knowledge is 'pulled' in by the host countries' given and matching expertise in certain areas, or whether it is 'pushed' by the source countries' desire to protect their own strengths internationally or at least in the region. This will give some indication of the technology gap between the Baltic States and the source countries and whether Ozawa's (1996) reasoning with respect to the 'Flying Geese' paradigm can be applied and maybe qualified for the context of transition economies.

A final section summarises the findings and concludes.

6.2 Reducing the Sample Size

The preceding chapter used a sample that included those source countries that transfer knowledge in the form of patent applications to at least one of the Baltic States, or that are noticeable innovators themselves. While this sample is arguably arbitrary to some degree (the method of choice risks omitting countries with deep links to the Baltics without transferring codified knowledge, for instance countries from the former

Soviet bloc), the regression results make it possible to reduce the sample size further to make an in-depth analysis feasible by pointing to the most relevant variables that influence knowledge flows – proximity, FDI and their own innovative capacity.

This follows the approach outlined in Chapter 4, which is narrowing the focus of the analysis to fewer source countries and in turn examines these specific knowledge flows in a much more thorough and detailed way. Resulting from the empirical findings so far (both from the regression analysis in the previous chapter and the issues presented in Chapter 2), several source countries warrant a deeper investigation. With a look at the variables most interesting in the context of this study, FDI and proximity, and their significance as well in theoretical and empirical terms[43], as well as staying in line with the theoretical considerations presented in Chapter 3, it is reasonable to limit the analysis to those countries that exhibit at least three of the following four characteristics:

- Source of significant knowledge inflows to the Baltic States, i.e. the strongest contributors to knowledge inflows, as it is primarily knowledge flows that this study examines
- Source of significant FDI inflows to the Baltic States, as it is assumed that direct involvement through FDI facilitates knowledge transfer best
- Geographical proximity to the Baltic rim – preferably direct access to the Baltic Sea (although not necessarily) to take into account proximity as a driver of knowledge transfer
- An innovative home economy, i.e. high PCT patenting per head, to accommodate the assumption of a catching up process of the Baltic States with other Western, innovation-driven economies

Given the differences between the regression results for Estonia and Latvia (and the lack of viable results for Lithuania), and the need for comparable data, six countries are

43 While the results presented in the preceding chapter were not always consistent across the countries and time periods, FDI and proximity have both been rather prominent in the findings – albeit with opposite influences in Estonian and Latvian reception of foreign patent extensions.

included in this smaller sample initially: the Nordic countries Sweden, Finland, and Denmark, as well as the US, the UK, and Germany. While the Baltic host countries and the comparison of them are the focus of this study, it is also interesting to make some comparisons between the source countries with respect to their connection to the Baltics. And as the preceding chapter has already shown that the Baltic States are all but one homogenous region, Norway, the fourth Nordic country, is added to the sample. Thus, there are two loose groups of source countries: the Nordic countries on the one hand, as small, highly developed and very open countries, and the industrialised world's 'heavyweights' with respect to both size of their economies and international innovativeness on the other.[44] With this smaller sample, an in-depth examination of knowledge inflows to the Baltic States becomes feasible.

6.3 Absolute Size of the Knowledge Inflows

The inflow of knowledge generated abroad increases the available stock of knowledge in the Baltic States, as outlined by Griliches' (1990) knowledge production function. Paci, Sassu, and Usai (1997) describe several reasons for firms to patent abroad: the protection of goods that are exported or of goods that might be subsequently produced abroad or licensed, or simply to facilitate technology and knowledge exchange. Yet despite these motives, according to theories of technology transfer, this knowledge is not only available to firms generating the knowledge but spills over to domestic firms and organisations, which use it to generate their own knowledge, thus altering their technology development path. Table 6.1 to Table 6.3 show patent applications in the

[44] Japan would fit into this group according to the definition, but has neither patent applications nor FDI in the Baltic States. Poland, on the other hand, would 'qualify' through its proximity, but is no great international innovator. Belgium and the Netherlands, as two small, open economies with relatively large knowledge inflows to the Baltics, seem interesting. However, as most of Baltic patent applications originating from there arrive through international patent systems, comparability cannot be guaranteed.

Baltic States broken down by country of priority. The first row in each table shows applications that originate in the home country.[45] The other rows represent the selected source countries and the other two Baltic countries.

Table 6.1: National patent applications in Estonia by priority country 1992-2004

Priority claimed in	*Publication Year* 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	sum
EE	0	0	0	2	19	15	23	24	13	20	26	30	16	188
SE	0	0	0	4	18	42	73	94	130	83	131	114	65	754
FI	0	0	0	13	44	25	37	45	43	19	39	49	21	335
DK	0	0	0	5	1	8	17	8	7	6	19	16	6	93
NO	0	0	0	1	1	1	2	5	1	3	2	7	2	25
US	0	0	0	4	34	64	135	181	189	138	292	268	136	1441
GB	0	0	0	3	7	30	49	47	48	35	73	70	60	422
DE	0	0	0	12	45	53	89	62	47	40	117	174	74	713
LV	0	0	0	1	0	1	0	2	1	2	0	1	0	8
LT	0	0	0	0	0	1	0	0	0	0	0	0	1	2
sum inflows	0	0	0	43	150	225	402	444	466	326	673	699	365	3793

Table 6.2: National patent applications in Latvia by priority country 1992-2004

Priority claimed in	*Publication Year* 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	sum
LV	0	29	126	256	317	152	157	128	115	104	96	111	97	1688
SE	0	11	57	26	45	21	7	3	3	2	0	1	2	178
FI	0	14	21	14	29	5	7	4	2	1	0	1	2	100
DK	0	5	20	7	7	10	0	0	2	0	1	2	0	54
NO	0	0	2	4	5	1	0	1	2	0	0	3	0	18
US	0	34	80	96	154	70	49	43	43	36	20	23	13	661
GB	0	48	76	32	53	16	8	3	1	4	0	1	3	245
DE	0	39	60	93	107	37	13	6	4	9	3	3	7	381
EE	0	0	0	0	2	0	0	0	1	1	0	0	0	4
LT	0	0	0	0	1	0	2	0	0	1	0	0	1	5
sum inflows	0	151	316	272	403	160	86	60	58	54	24	34	28	1646

45 While these patent applications do not constitute knowledge inflows but knowledge generation (which will be examined in the following chapter), they serve as a means to show the weight of inflows in comparison to the 'home front' of patenting activities in this context. It can already be seen that Estonia has a much higher share of foreign knowledge in domestic applications than Latvia and Lithuania.

Table 6.3: National patent applications in Lithuania by priority country 1992-2004

Priority claimed in	Publication Year 1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	sum
LT	4	190	247	175	121	118	129	95	102	74	70	90	68	1483
SE	0	20	35	59	3	3	4	2	3	2	0	0	2	133
FI	0	10	23	21	2	2	4	5	1	1	0	1	0	70
DK	0	4	12	12	1	1	0	0	0	1	0	1	0	32
NO	0	0	0	6	1	0	2	1	1	0	1	1	0	13
US	0	30	80	96	15	26	19	25	29	25	16	15	11	387
GB	2	32	45	49	1	2	4	0	0	0	0	1	2	138
DE	2	27	68	117	12	14	7	6	1	5	7	5	4	275
EE	0	0	0	0	1	1	0	0	0	1	0	0	1	4
LV	0	0	3	1	0	2	0	2	0	0	1	1	0	10
sum inflows	4	123	266	361	36	51	40	41	35	35	25	25	20	1062

The inward knowledge flows, defined as patent applications filed and published in either Baltic State that claim a foreign priority, vary significantly between the countries. Estonia started recording national patent applications claiming a non-Estonian priority only in 1995, while Latvia and Lithuania have their first filings as early as 1993 and 1992 respectively. Still, compared to the other two, it is Estonia that is the largest receiver of those patent applications originating from the countries in the table. The total inflow into Estonia between 1992 and 2004 amounts to 3,793 patent applications, while Latvia recorded 1,646 and Lithuania even fewer with 1,062 applications in the same time period. Taking into account the population sizes makes the picture even more striking: For the total time period in question and without accounting for trends the number of patent applications that have flowed in per 1 million population are 2,632 in Estonia, 668 in Latvia, and only 298 in Lithuania. As all three countries have experienced a marked decrease in their populations[46], the population sizes in 1992 and 2004 were averaged to account for this development.

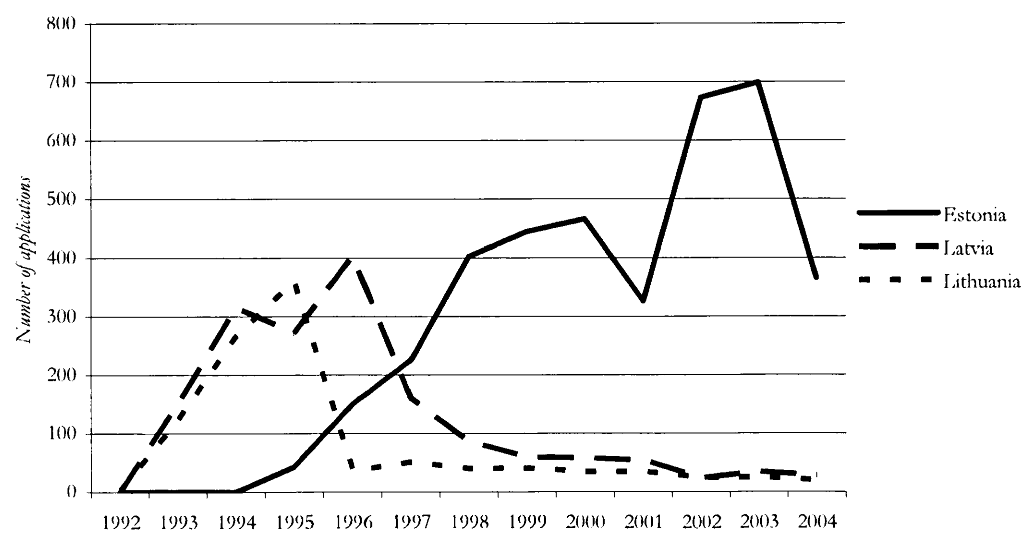
The tables show that with the exception of Norway and despite their small sizes, the Nordic countries make a significant contribution to knowledge inflows, particularly in the early years of independence. While the knowledge flows from Sweden and Finland

[46] As reported in Chapter 2 previously, between 1992 and 2004, Estonia experienced a 12% decrease of its population, Latvia, 11.5%, and Lithuania 7.1%.

are particularly strong, Denmark's are smaller, but still significant for such a small source country. With respect to absolute size, the source country making the biggest contribution to the knowledge inflows is the US, which is hardly surprising, given that it is not only the largest country but also strongest innovator of all source countries in the sample. However, the sum of the Nordic countries' inflows easily matches this, when their size is considered. Intuitively, this confirms the tentative finding of the previous chapter that geographical proximity is indeed a factor that encourages the decision to extend patents to another country and also confirms the assumptions outlined in Chapter 3.

Apart from the differences in the sheer volume of these inflows to the Baltic States, Figure 6.1 illustrates that their strength varies considerably not only between the three recipients, but also over time. It should be noted that the 2004 figures are still incomplete due to some reporting lags and delays in the digitalisation of the data.

Figure 6.1: Knowledge inflows into the Baltic States from selected source countries, 1992-2004



While Estonia has recorded continuous growth in the number of patent applications with only one dip in 2001, the picture in Lithuania is the exact opposite. Applications peaked in 1995 and have since then dropped sharply and, with the only exception of US priorities, continuously declined. Inflows from all origins except Finland peak in that year, with German (117) and US (96) contributions being strongest, followed by applications originating in Sweden (59) and the United Kingdom (49). What is even more striking than this early surge is the sharp decline that occurred from 1995 to 1996. The number of German priority documents fell by 89.7% that year, applications originating in the US by 84.4%, while Swedish and British priorities suffered even sharper falls with 94.9% and 98% respectively. After 1996, only the US contribution recovered slightly, although it never reached previous levels.

The pattern that Latvia exhibits is very similar to the Lithuanian one: after 1992, inflows from all origins rose sharply, most of them peaking in 1996 and then declining again gradually. Applications claiming a US priority were strongest in the earlier stage of transition, closely followed by German inflows. However, while the number of documents with US priority has declined gradually, their German counterparts disappeared abruptly around 1998, having peaked at a massive 107 applications in 1996. From 1997 to 2004, only an average of 10.25 Latvian applications per year claims a German priority.

This could have something to do with the difficulties that foreign firms face that Ghauri and Holstius (1996) identified: That, while it is relatively easy to establish first contacts and set up shop in the Baltic States, running a subsidiary there is in reality much harder and an easy entry is often followed by mounting problems with respect to the actual operation of the firm. Another possible explanation is that after initial optimism with respect to the speed of market reforms in the Baltics, a pattern of preserving traditional knowledge creation patterns and a focus on dealing with everyday survival in the face of economic and social turbulence has prevailed for the time being (Radošević 2003). This would point to a lack of absorptive capacity in Latvia and Lithuania, or at least a lack of it as it is perceived by MNEs who do not feel the need to protect their knowledge there. However, absorptive capacity (real or perceived) is not explicitly assessed in this study – it would be a rewarding issue to pursue further at a later time.

As patent applications can claim a priority from a regional or the international patent regime, there are knowledge inflows into the Baltic region whose origin cannot be identified as easily. Yet as European and international applications are usually filed for internationally competitive inventions, they are reported in Table 6.4. The table shows the growing importance of patent applications with European priority in Estonia, while in Latvia the greatest inflows were recorded over a short period in the mid-1990s.

Table 6.4: Knowledge inflows from supranational patenting activities[47]

		Publication Year												
		1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Estonia	**EP**	0	0	0	0	2	12	16	27	28	13	66	86	52
	PCT	0	0	0	5	40	157	363	433	497	325	732	845	489
Latvia	**EP**	0	3	13	9	45	25	8	6	1	1	0	2	0
	PCT	0	0	2	9	46	53	52	59	106	183	140	141	14
Lithuania	**EP**	0	4	7	15	2	2	1	2	1	2	1	2	0
	PCT	0	0	5	7	1	1	1	0	0	2	1	0	0

Generally, PCT priorities are by far the strongest contributors to the inflows into Estonia and Latvia, having peaked at a total of 845 (2003) national applications in the former and 183 (2000) in the latter. However, it should be remembered that a blanket extension at the point of filing the PCT application could automatically translate into a Baltic national application, once the international stage is completed, only to be withdrawn later when extension fees are due. Thus, PCT applications are usually not targeted at particular countries, much less the Baltics. In Latvia they have only become strong recently, having surpassed applications claiming a US priority in 1998. In

[47] The PCT inflows into Estonia in 2002 and 2003 are estimates, as the number of results is too high for esp@cenet to give more than an estimate. However, the figures should not be more than 10% larger than the real values. Despite the time that has elapsed between the 2004 reporting and today, numbers are still incomplete due to lags in the grant procedure and sluggish upload into the online database.

Lithuania, PCT applications that translate in to national ones hardly seem to matter at all.

Ideally, the data on international and European priorities should be converted to country of origin information as shown in Table 6.1 to Table 6.3. This is more easily accomplished for European priority documents than for World patents due to sheer numbers and the nature of the World patent application.

In the case of PCT patent applications, the legal process of the application helps in-sofar, as the vast majority (more than 80% of documents) claim multiple priorities. As a PCT patent application is usually filed with a national (or, in the case of the EPO, regional) patent office, this national origin is reflected in corresponding national priority, so that a large amount of the relevant PCT inflows in Table 6.4 is already captured in the earlier tables. As this study is concerned with the relationships between host and source countries, 'pure' PCT patent applications are not explicitly taken into account, as they are by definition not targeted at the Baltic States in particular.[48] The population of patents unaccounted for are thus those applications that carry a combined EP/ PCT priority, which is the majority of those with an EP priority.

With respect to patent applications claiming European priority, the country of origin can, in theory, be traced either through the country of the applicant or through the priority that the European priority document itself claims. However, an inspection of applications with an EP priority shows that the applicant's choice is normally an *either-or* decision, i.e. either only a national or a European patent is attempted; almost never does a European application follow a national one. Where there are multiple priorities, it is EP and PCT – this is because the EPO acts as a receiving office for PCT applications, if

[48] PCT patent applications that have a multiple priority – one from a source country and the PCT one – might not be specifically targeted at the Baltic States, either and thus create noise. However, there are not too many of those priority combinations, to that it can be assumed they do not overly skew the numbers.

the applicant chooses so (what is called the Euro-PCT route). In the case of documents with an EP (and additional PCT) priority, this obviously creates a 'lost' flow in terms of an inflow that cannot be traced to its origin in the way this study does. To guarantee that no major inflows are missed, and to gauge the size of the possible loss, those applications with an EP priority are broken down by the applicant's nationality. Additionally, the proportion of EP/ PCT priorities in relation to all EP priority documents is reported. Breaking this sub-population down by applicant nationality is however not consistent with the overall methodology of this study, which proxies the origin of knowledge by priority alone, rather than applicant nationality.[49] This detour is necessary, though, to get an impression of the 'hidden' knowledge flows in the overall sample of patent applications that are extended to the Baltic States. The results for this breakdown are reported in Appendix B.1.2, reporting almost all source countries that appear. Focusing only on the source countries already selected would limit the possibility of finding real lost inflows. However, due to the methodological inconsistency of this part of the analysis, even strong inflows would have to be dealt with separately at a later stage.

Applicants from four countries are choosing the Euro-PCT route to obtain PCT patent and extend them to the Baltic States regularly, three of them apparently preferring this route over bilateral of 'national-PCT' ones. While Germany is already included in the sample of source countries, the Netherlands, Belgium, and Switzerland all extend patents to the Baltic States through the purely international route. Like Germany, subjects from there also file priority documents nationally – all were included in the wider sample of the previous chapter for this reason. However, both the Netherlands

[49] As will be shown in section 6.4.2 of this chapter, these two different approaches produce indeed slightly different results. Using priority numbers traces the actual origin of the knowledge codified in a patent more accurately, whereas the identification of the applicant's nationality identifies just that – the applicant's nationality.

and Belgium contribute significantly to the Euro-PCT knowledge inflows, to Estonia in particular, which peak at 17 and 22 patents applications in 2002 respectively, providing together 68.4% of all Euro-PCT inflows in that year. Of the Belgian EuroPCT applications, the large majority are filed by Belgian-American firm Janssen Pharmaceutica, which also appears in the US-Estonia knowledge flows, if only occasionally. It seems that Janssen prefers the purely international approach to protect its inventions to more direct ones. This contribution is much less pronounced in Latvia and Lithuania, where patent applications coming through the Euro-PCT route do not matter much at all. The most persisting patenting comes from Germany, whence at least one patent is filed in Latvia and Lithuania in most years, and a continuously rising number (up to 24 in 2003) in Estonia. However, patent applications with a German priority number far outweigh these Euro-PCT applications.

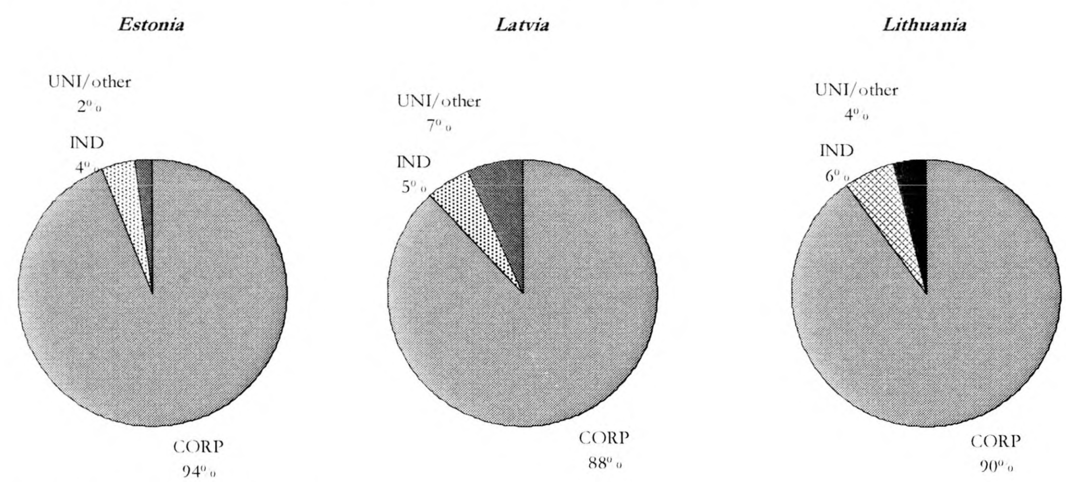
Another issue that needs to be considered is the share that patent applications that come through the Euro-PCT route have in the overall knowledge inflows to the Baltic States. Apart from Estonia (and only in the later years) the numbers are very small throughout, so despite the interesting observation that firms from small, open economies seem to rely more strongly on the international patent regimes when taking their knowledge abroad, no major gaps in the existing data have been identified. However, the importance that particularly the PCT system has for small economies will guide the later examination of knowledge generated in the Baltic States in the following chapter.

6.4 The Institutional Base of the Knowledge Inflows

6.4.1 Aggregate Analysis

As outlined in Chapter 4, knowing the institutional base of innovative activities helps in assessing the process of transition from a centrally planned, government-dominated to a market economy that is driven by private enterprise. However, as it is the knowledge inflows from Western economies that are analysed in this chapter, one would hardly expect anything but a firm-dominated field of applicants of patents in the Baltic States. On the other hand, confirming this assumption would re-enforce the claim that despite their small size, the Baltics are attractive for MNEs' knowledge – either because their markets are attractive in themselves, or because MNEs expect enough absorptive capacity there that their products and processes need strong protection. The institutional base of all knowledge inflows under consideration is depicted in Figure 6.2 below.

Figure 6.2: Knowledge inflows 1992-2004, broken down by applicant type



CORP = Corporate patent application;
IND = individual patent application;
UNI/other = university/ research institution patent application or unknown

It becomes obvious that indeed the great majority of patent applications in the Baltic States whose content originates elsewhere is made by firms, accounting for around 90%. The category UNI includes mainly university applicants, but also very few independent research institutions (namely the German Fraunhofer Institut and the British Wellcome Foundation), and in the case of Latvia those applications that state neither inventor nor applicant in the bibliographic information made available by the EPO.[50] While the institutional structure of the inflows is similar for all source countries and mirrors the aggregate inflows shown in Figure 6.2, some differences exist.[51] Knowledge inflows from the Nordic countries are almost entirely in the form of corporate patent applications (CORP), with only relatively few individuals and no university taking out a patent in the Baltics. Most individual and university applications claim priority in the much larger economies of the US, the UK, and Germany. It is possible that these applications are indiscriminate in that they are extended 'everywhere', rather than be targeted at one particular country, because a large number of these patent applications in the Baltics come through the PCT route of obtaining national IP protection, where the actual target is the international community itself.

The literature partly confirms this when stating that the role of universities within an innovation system is usually the provision of incremental or generic (where patentable), rather than applied research (Lundvall 1992, Sapsalis, van Pottelsberghe de la Potterie and Navon 2006). As such, the emission of that knowledge should be less targeted – unless the university forms the nucleus of a local network (Pollard 2006), in which case the emanation would be highly localised. While a firm takes out a patent to achieve a temporary monopoly in a market, a university usually has an interest to publicise a technological advance widely (Sapsalis, van Pottelsberghe de la Potterie and Navon 2006). This generic knowledge would thus be targeted less at specific channels of

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50 The blank patent applications appear only in Latvia, and are presumably due to the digitalisation of Latvian records for inclusion into esp@cenet: They appear mostly in the first half of the time period under analysis, and their number falls as time progresses. In some cases, the accurate information can be extracted from the original Latvian document, but as this is not always possible, and the number of 'unknowns' is too small to distort the overall picture, this has not been done – accepting 'unknowns' as just that.

51 The breakdown of the numbers by source country, documented in Appendix B.1, shows that in detail.

technology transfer, such as alliances working to a common end (Radošević 1999a), but more at a wider audience, namely the scientific community as a whole. A much closer look at who actually applies for patents in the Baltics will take up this theme of targeted knowledge emanation.

6.4.2 Spotlight on Applicants

Moving away from aggregate analysis, whether across countries or by country, and taking a closer look at the actual actors that extend their specific and already codified knowledge to the Baltic rim, some interesting patterns emerge. It is important to remember that the priority number captures the origin of the knowledge and not the origin of the applicant or the inventor. Thus in looking at the actual applicant, the analysis leaves the original path of looking exclusively at knowledge itself, rather than its creator, in the same way the breakdown of the Euro-PCT knowledge inflows by the applicants' nationality has done. However, it aids the overall understanding of whose knowledge exactly is transferred, and whether the origin of the knowledge captured by the patent equals that of the applicant of the patent.

The assumption that universities and other research institutions disclose their scientific achievements more indiscriminately can be broadly upheld: The same applicant usually appears in the patent application records of all three Baltic States, with no more than a year's difference. A casual look at the actual application details confirms that it is usually the same priority document that is extended. This holds true for almost all non-corporate institutions, as the tables in Appendix B.1.4 show. The Fraunhofer Institut (DE), the Wellcome Foundation (GB), several British (Aberdeen, Coventry, etc.) and American (Washington, Ohio, Massachusetts, etc.) universities, and the Oregon State and British Governments all contribute to the knowledge inflows in each Baltic State. Universities' and similar institutions' patent applications (or rather the knowledge contained in them) are mostly rooted in the US, with only a few coming from Britain and hardly any from other source countries. This could be simply a matter of conventions in the source countries with respect to academic patenting, or it could point to a more active, revenue-driven role of academia in Anglo-Saxon national innovation systems.

Patent applications made by individuals follow this pattern: When a patent is applied for in any one of the Baltic States by a natural person, the same application usually appears in the two other countries. No effort has been made to identify these individuals other than by name, yet two things have to be considered: (a) Some universities and research institutions allow their employees to apply for a patent under their own name, rather than assign it to the institution; and (b) as this study uses patent applications, some of these applications that come through the PCT route in particular might be withdrawn once they translate into actual fees for the applicant. As a result, a certain share of individual patent applications might be 'void', either being attributable to the category UNI, or being non-extant in the long run for reason of withdrawal.

Corporate patent applications in the Baltic States are, if not entirely, significantly different. While there are strong overlaps, particularly from the big source countries, with source country firms that extend their patents to the Baltic States both in large numbers and quite persistently, usually doing so in all three countries – despite the decrease of inflows to Latvia and Lithuania, the few remaining patents are often from applicants that have patented there earlier (the German firms Bayer, Hoechst, and Boehringer being one example). Summary statistics for the corporate patent applications from all source countries except Norway and Denmark are reported in Table 6.5 to Table 6.7 below.[52]

Table 6.5: Summary statistics for corporate patent applications claiming a foreign priority in Estonia

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	corporate inflows	0	0	0	4	16	42	68	90	126	78	129	113	65
	patents per firm	0.0	0.0	0.0	1.3	2.7	4.2	2.4	3.8	4.8	3.9	5.6	4.3	4.3
Sweden	number of nationalities	0	0	0	2	1	2	5	4	5	2	5	5	4
	% SE firms	n/a	n/a	n/a	66.7	100.0	90.0	85.7	83.3	80.8	90.0	87.0	84.6	80.0
	% of inflows by top3 firms	n/a	n/a	n/a	100.0	81.3	78.6	57.4	66.7	69.0	69.2	77.5	62.8	73.8
	corporate inflows	0	0	0	11	40	21	32	41	37	19	32	44	19
	patents per firm	0.0	0.0	0.0	1.2	1.6	1.1	1.3	1.3	1.3	1.2	1.5	1.5	1.4
Finland	number of nationalities	0	0	0	1	1	2	2	2	1	1	2	2	1
	% FI firms	n/a	n/a	n/a	100.0	100.0	94.7	95.8	96.9	100.0	100.0	95.5	96.6	100.0
	% of inflows by top3 firms	n/a	n/a	n/a	54.5	40.0	23.8	25.0	29.3	24.3	31.6	40.6	25.0	36.8
	corporate inflows	0	0	0	4	33	57	132	175	176	134	274	259	127
	patents per firm	0.0	0.0	0.0	1.0	1.9	1.5	2.4	3.2	3.3	3.3	3.6	2.7	2.3
US	number of nationalities	0	0	0	1	5	9	8	10	13	11	15	17	15
	% US firms	n/a	n/a	n/a	100.0	70.6	68.4	74.5	58.2	69.8	56.1	55.8	57.3	44.6
	% of inflows by top3 firms	n/a	n/a	n/a	75.0	42.4	24.6	31.8	49.1	40.9	55.2	36.5	32.8	46.5
	corporate inflows	0	0	0	3	6	25	43	45	46	29	69	67	57
	patents per firm	0.0	0.0	0.0	1.0	1.2	1.4	2.0	1.8	2.2	1.6	3.5	2.3	2.5
UK	number of nationalities	0	0	0	3	5	7	9	9	8	8	10	10	10
	% UK firms	n/a	n/a	n/a	0.0	20.0	61.1	52.4	52.0	47.6	50.0	45.0	44.8	39.1
	% of inflows by top3 firms	n/a	n/a	n/a	100.0	66.7	36.0	39.5	40.0	52.2	48.3	63.8	50.7	49.1
	corporate inflows	0	0	0	12	43	50	81	56	44	37	107	166	73
	patents per firm	0.0	0.0	0.0	1.2	2.4	1.9	2.5	1.8	1.6	1.6	2.2	3.8	2.5
Germany	number of nationalities	0	0	0	2	6	3	4	5	3	5	7	4	3
	% DE firms	n/a	n/a	n/a	90.0	72.2	88.5	87.5	81.3	82.1	78.3	83.7	90.9	89.7
	% of inflows by top3 firms	n/a	n/a	n/a	41.7	60.5	42.0	40.7	28.6	27.3	24.3	29.9	47.0	42.5

Table 6.6: Summary statistics for corporate patent applications claiming a foreign priority in Latvia

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	corporate inflows	0	9	55	25	32	11	7	3	3	2	0	1	2
	patents per firm	0.0	1.1	4.6	2.3	2.7	1.4	1.2	1.0	1.0	1.0	0.0	1.0	1.0
Sweden	number of nationalities	0	2	3	3	3	1	1	2	2	1	0	1	1
	% SE firms	n/a	87.5	83.3	81.8	83.3	100.0	100.0	66.7	66.7	100.0	n/a	100.0	100.0
	% of inflows by top3 firms	n/a	44.4	52.7	64.0	34.4	54.5	57.1	100.0	100.0	100.0	n/a	100.0	100.0
	corporate inflows	0	14	17	12	19	3	7	4	2	1	0	1	2
	patents per firm	0.0	1.8	1.4	1.1	1.6	1.0	1.2	1.0	1.0	1.0	0.0	1.0	2.0
Finland	number of nationalities	0	2	1	1	2	1	1	1	1	1	0	1	1
	% of FI firms	n/a	87.5	100.0	100.0	91.7	100.0	100.0	100.0	100.0	100.0	n/a	100.0	100.0
	% of inflows by top3 firms	n/a	57.1	41.2	33.3	52.6	100.0	57.1	75.0	n/a	n/a	n/a	n/a	n/a
	corporate inflows	0	32	71	84	118	47	41	42	41	36	17	23	13
	patents per firm	0.0	3.2	1.8	2.1	2.1	1.7	1.7	2.0	1.7	2.3	2.1	2.3	1.4
US	number of nationalities	0	6	8	9	13	7	4	6	4	4	2	3	4
	% US firms	n/a	50.0	71.8	72.5	64.3	75.0	83.3	76.2	87.5	81.3	87.5	70.0	66.7
	% of inflows by top3 firms	n/a	71.9	26.8	27.4	29.7	36.2	41.5	42.9	36.6	44.4	70.6	65.2	53.8
	corporate inflows	0	43	68	29	38	12	7	3	1	4	0	1	2
	patents per firm	0.0	3.3	2.3	1.5	1.7	1.0	1.2	1.0	1.0	1.3	n/a	1.0	2.0
UK	number of nationalities	0	9	9	10	10	6	6	3	1	1	0	1	1
	% UK firms	n/a	30.8	48.3	35.0	36.4	58.3	16.7	33.3	100.0	100.0	n/a	100.0	100.0
	% of inflows by top3 firms	n/a	51.2	27.9	34.5	34.2	25.0	57.1	100.0	100.0	100.0	n/a	100.0	100.0
	corporate inflows	0	32	52	74	60	21	9	5	2	7	2	3	5
	patents per firm	0.0	2.5	1.8	2.2	1.6	1.3	1.1	1.3	1.0	1.8	1.0	1.5	1.3
Germany	number of nationalities	0	2	4	6	5	3	4	1	1	2	1	1	1
	% DE firms	n/a	92.3	82.8	84.8	88.9	87.5	50.0	100.0	100.0	75.0	100.0	100.0	100.0
	% of inflows by top3 firms	n/a	56.3	52.0	41.9	20.0	38.1	44.4	80.0	n/a	66.7	n/a	n/a	100.0

52 As can be seen from Table 6.5 to Table 6.7 already, small numbers tend to exaggerate the values for concentration and 'multinationality'. As Denmark and Norway both exhibit small and volatile knowledge flows to the Baltics, they are excluded from the summary tables. The full tables for all source/ host country pairings are reported in Appendix B.1.3.

Table 6.7: Summary statistics for corporate patent applications claiming a foreign priority in Lithuania

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	corporate inflows	0	18	34	54	3	2	4	2	3	2	0	0	2
	patents per firm	0.0	2.3	2.3	3.6	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1.0
Sweden	number of nationalities	0	1	3	5	1	1	2	1	2	1	0	0	2
	% SE firms	n/a	100.0	86.7	66.7	100.0	100.0	75.0	100.0	66.7	100.0	n/a	n/a	50.0
	% of inflows by top3 firms	n/a	72.2	55.9	70.4	100.0	n/a	75.0	n/a	100.0	n/a	n/a	n/a	n/a
	corporate inflows	0	10	22	21	2	2	4	5	1	1	0	1	0
	patents per firm		1.7	1.8	1.8	1.0	1.0	1.3	1.0	1.0	1.0	n/a	1.0	0.0
	number of nationalities	0	1	1	1	1	1	1	1	1	1	0	1	1
	% FI firms	n/a	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	n/a	100.0	100.0
	% of inflows by top3 firms	n/a	70.0	45.5	52.4	n/a	n/a	100.0	60.0	n/a	n/a	n/a	n/a	n/a
	corporate inflows	0	29	76	84	15	21	18	22	25	23	15	14	10
	patents per firm	0.0	2.9	2.1	1.6	1.3	1.1	1.4	1.3	1.7	2.3	1.2	3.5	1.0
US	number of nationalities	0	4	7	7	2	2	3	5	2	3	3	2	4
	% US firms	n/a	70.0	72.2	76.5	91.7	90.0	84.6	76.5	93.3	70.0	84.6	50.0	70.0
	% of inflows by top3 firms	n/a	58.6	23.7	17.9	33.3	19.0	27.8	36.4	52.0	60.9	26.7	92.9	30.0
	corporate inflows	2	26	38	48	1	2	3	0	0	0	0	0	2
	patents per firm	2.0	2.6	1.8	2.1	1.0	1.0	1.0	n/a	n/a	n/a	n/a	n/a	1.0
UK	number of nationalities	1	7	8	11	1	2	3	0	0	0	0	0	1
	% UK firms	100.00	20.0	52.4	34.8	100.0	50.0	33.3	n/a	n/a	n/a	n/a	n/a	100.0
	% of inflows by top3 firms	n/a	65.4	36.8	31.3	100.0	100.0	100.0	n/a	n/a	n/a	n/a	n/a	100.0
	corporate inflows	2	23	62	104	9	12	7	4	1	4	6	5	2
	patents per firm	2.0	2.1	1.6	1.9	1.1	1.5	1.4	1.3	1.0	1.3	1.2	1.7	1.0
Germany	number of nationalities	1	1	3	4	4	2	2	1	1	1	2	1	1
	% DE firms	100.00	100.0	95.0	89.3	62.5	87.5	80.0	100.0	100.0	100.0	80.0	100.0	100.0
	% of inflows by top3 firms	n/a	52.2	22.6	27.9	44.4	50.0	57.1	100.0	n/a	100.0	67.7	100.0	n/a

Looking at the source countries of knowledge briefly, a few general observations can be made.

The smaller source countries, i.e. the Nordic countries, have a more homogenous field of applicants with respect to nationality. Patents applied for in all Baltic States, which claim priority in Finland, Denmark, or Norway, name almost entirely applicants of that respective nationality. Very few applicants that extend Finnish priority documents are Swedish and vice versa, and the smaller the country, the fewer 'foreign' applicants appear. Conversely, the larger source countries usually have more diverse applicants with the UK having generally the lowest proportion of indigenous UK firms contributing to the numbers of patent applications (as low as 17% in Latvia in 1998, although based on a small overall amount). This is closely followed by applications claiming a US priority, whose largest inflows to Estonia exhibit the lowest share of American applicants with just under 60% of the total US inflow. While for the US, this is least surprising, with US patents still being an 'international' patent of choice for many applicants, it is also relevant that many MNEs come from these leading economies and will probably have widespread R&D networks.

The example of AstraZeneca illustrates this point: while formally a Swedish company, a significant number of its patents claims a British priority, as R&D is still done by what was formerly British Zeneca. AstraZeneca (Astra before the merger with British Zeneca in 1999), in all its 'guises' as Swedish Astra, British Zeneca, and again Swedish AstraZeneca, appears in the knowledge inflows from the UK to Estonia as well, at times as a very strong contributor. In 2003 for instance, AstraZeneca tops the list of applicants with 20 out of 70 applications, in 2002 and 2004 it ranks second, while the combined applications of Astra and Zeneca are usually among the strongest contributors to UK-Estonian knowledge flows. This is different in Latvia and Lithuania, where patent applications from the two (later one) firms are fewer and disappear completely in later years. Also, it is Zeneca, rather than Astra, taking out those patents. Swedish lockmaker Assa Abloy is another Swedish MNE that contributes to knowledge inflows in all three countries (with priority numbers from several source countries), and again it is Estonia which receives most patent extensions over time. However, while the Baltics, among other regions, are identified as growth markets, Assa Abloy does not seem to have set up production in either of the three countries (Assa Abloy 2005).

The German pharmaceutical companies Bayer, Hoechst, and Boehringer follow this pattern as well. They are strong and relatively persistent applicants in all three Baltic States, yet appear as German, American, British and sometimes Canadian firms, contributing to various bi-national knowledge flows under analysis by extending patents based on diverse priority numbers.

However, they do not necessarily do so to the same extent everywhere, often concentrating their activity in one country. Turning to AstraZeneca again, the MNE dominates Swedish knowledge inflows to Estonia by making half of all patent applications there before 1999 and still about a quarter afterwards (the fall of the share mainly due to growing overall numbers), but has far fewer applications in the other two countries. Where applications are made in Latvia and Lithuania, they occur in the time right after independence. So while Estonia stays an attractive location for AstraZeneca throughout, with even rising absolute numbers of applications there, the other two countries are, in line with the development of aggregate knowledge inflows, obviously losing their appeal after about 1996. After an initial surge of patent applications from AstraZeneca, they fail to attract any at all in the later years. However, the firm has no R&D facilities in either Baltic State, despite a general presence there (AstraZeneca 2007), not surprising for host countries in the 2nd or early 3rd stage of the IDP. Without access to the details of what AstraZeneca does in which Baltic State (merely distribution or also production), the number of patent applications in each country makes Estonia look the most successful host country, attracting more knowledge that continuously flows in. This points to a greater ability to absorb this knowledge, while in Latvia and Lithuania the inflows cease after the initial transfer of patents in the early years of transition, suggesting a lack of continuous accumulation of knowledge and the upgrading (Lorentzen and Barnes 2006) of the existing knowledge stock.

Interestingly, Swedish firms also feature strongly in US knowledge flows to Estonia. Here, it is mostly telecoms giant Ericsson, appearing both as a Swedish and an American firm, that extends US priority documents to Estonia – as much as 46% of all American knowledge inflows in 2001, after having contributed 41% and 31% in the two preceding years respectively. Ericsson also contributes strongly to Swedish knowledge flows to Estonia between 1999 and 2002. Given the Swedish (and Finnish) involvement in the privatisation of Eesti Telekom, which is the largest foreign affiliate in the country (Swedish Telia, part of the consortium, also contributes significantly to Swedish-Estonian knowledge flows), it is not surprising that Ericsson's patents 'follow' to Estonia. Ericsson does not appear once (with a priority document from any source country) in the other two Baltic States. Only Estonia attracts patent applications from firms in the telecommunications field, which has possibly historical reasons, as the country had a quite active telecommunication sector in Soviet times, which it is trying to preserve (Högselius 2002). Meanwhile, the majority of firms that apply for patents in Latvia and Lithuania are well-known MNEs from the pharmaceutical, or more broadly the chemical, industries. Estonia attracts those patents as well – and overall more successfully, with its much higher absolute inflows – and it succeeds in attracting persistent patenting.

Finnish, Danish, and Norwegian knowledge inflows do not follow the general pattern of being dominated by companies from chemical industries that dominate the field of applicants from other source countries. Knowledge flows from Finland are generally diverse and hardly ever concentrated on just a few applicants, the share that the three most active applicants have in the overall mass of applications is small compared to other source countries. One exception is Kemira, a chemical MNE that focuses on pulp and paper, water treatment and performance chemicals as well as paint. Several patent extensions are made to Estonia over the years (although much smaller numbers than previously mentioned MNEs with a maximum of four applications in 2004), where it also owns a production subsidiary, Kemivesi AS; in Latvia and Lithuania, only distribution centres have been established (Kemira 2005). Given the close links between Finland and Estonia, both cultural and linguistic, as well as their immediate neighbourhood, it does not seem surprising that the production site was established in Estonia.

The knowledge inflows from Denmark and Norway are generally too weak to allow for any skewness. The most concentrated knowledge flows originate in Sweden and Germany, where each year a handful of companies apply for the majority of patents in the Baltic States. Knowledge flows from Germany have the most homogenous field of applicants, with usually around 80% (or more when inflows are weak) of the applicants being German. While not used as an international patent system like US patents, this prevalence of German firms could point to Germany's position as a highly innovative economy with a strong national IP protection tradition. Historical links with the Baltic States would then explain the strong push by German firms towards the region.

Given the concentration of the majority of the knowledge flows to the Baltic States, the question arises whether these patent applications are also concentrated in particular technological fields. Therefore, in the following section the focus of the analysis shifts from the 'who?' to the 'what?' – i.e. which technology is sought protection for in the Baltic host countries, and how does that match with the capabilities the host or source countries themselves exhibit in their patenting.

6.5 The Technological Profiles of Knowledge Inflows

As outlined in Chapter 4, the reasons for extending existing patents to the Baltic States can be twofold: Either protection for internationally competitive inventions is sought in the catching up economies of Central and Eastern Europe, without necessarily targeting one or all of the Baltic States specifically; or the Baltics offer locational advantages that attract specific knowledge, which matches with either existing or potential strengths in the countries.

The first motive represents a 'push' factor, where the decision to extend patents to the Baltic States is not strongly influenced by the characteristics of the host country, but by a more general desire of source country firms (or universities or individuals) to protect internationally competitive knowledge. In this case, the technological profile, i.e. the relative strengths and weaknesses in certain technological fields, that the knowledge flows from one source country to a Baltic State exhibit, should roughly mirror the international, PCT, profile of that source country. It stands to reason that, as the Baltic States receive knowledge inflows from more than one source country, profiles will never match completely, however, given the differing composition of those inflows with respect to the relative share of different source countries' contribution and – as demonstrated in the previous section – the actual applicants, the Baltics' profiles should differ from each other to some extent. Accordingly, this 'push' hypothesis simply states that knowledge inflows into the Baltic States will mirror general international (PCT) patenting activities by the source countries.

The second motive, on the other hand, constitutes a 'pull' factor for the extension of patents to the Baltic States. In this case, it is the particular characteristics of the host country, whether a skilled workforce, domestic demand and competition or the creation of a viable production base to serve more markets than just the domestic one (all these characteristics translate into the host country's attraction for foreign IP protection), that draw in the knowledge from the source country. Focusing on what Verspagen (1999) terms technological congruence (a notion similar to the technology gap, but aimed more strongly on the match between host and source country technologies) and social capability (broadly similar to absorptive capacity and its determinants), in this case the technological profile of the knowledge inflows should match the profiles of Baltic patenting activities, either domestic or international. Thus, the 'pull' hypothesis is that only those patents are extended to the Baltic States that require explicit protection there from imitation or competition and it is accordingly the domestic profiles of the Baltics that become the focus.

A possible third motive emphasises the importance of proximity, both geographic and cultural. Provided the source and host country are close enough to each other, smaller and generally less internationally oriented firms than 'typical' MNEs may be encouraged to get involved in the host country. In line with the Scandinavian school of internationalisation, making the move to a close-by country is then a first and incremental step of internationalisation (although the SME might not necessarily ever progress beyond this first step), as the host country is perceived as less alien that a foreign environment would usually be. In this third case, the technological profile that the knowledge inflows have should be most similar to the domestic profile of the source country, rather than its international one. Paci, Sassu, and Usai (1997) show that technological specialisations differ between the international and the domestic spheres, as not all knowledge that is important within an economy is necessarily internationally competitive. As a result, smaller firms that only extend their patents to the Baltics but would otherwise not consider international activities would be in line with domestic patenting of the source country.[53] However, assessing the domestic technological profiles of the source countries lies beyond the scope of this study. This aspect of the extension of patents to the Baltic States could be described as a transaction cost hypothesis: that it is proximity and the resulting reduction in transaction costs that influences both 'pull' and push' factors.

6.5.1 Comparing Technological Specialisations

As Section 6.3 of this chapter has demonstrated, the patterns and volume of the knowledge inflows into each Baltic State vary significantly over the time period under analysis. To account for these developments and still have large enough numbers to calculate meaningful revealed technological advantage (RTA) indices in most cases, similar to the preceding chapter, the overall time period is broken down into two periods, period 1, which covers 1992 to 1998, and period 2, covering 1999 to 2004.

[53] One methodological issue arises here: Esp@cenet, which provides the data on national patent applications, limits its output for each search to 500 documents. As this output is initially a 'first guess' (although usually a rather informed one) and a certain amount of double-counting within patent families is eliminated only when the user is running through the results, any number above 500 documents is an approximation. Thus, the resulting RTAs could only reflect tendencies at best, and are not completely accurate.

6.5.1.1 Comparison between Inward and Source Country PCT RTAs

To examine the first motive for extending patents to the Baltic States, the source countries' RTA profile within each Baltic country (the inward profile), is compared, where possible, to the respective source country's patenting profile in the PCT system. As explained previously in Chapter 4, the technological field a patent application belongs to is proxied by its main international patent classification (IPC) stated on the front page.

Table 6.8 and Table 6.9 report this comparison for knowledge inflows to Estonia for both time periods separately, with the correlation coefficient for each pairing as well. RTAs represent relative performances in each field, with the 'neutral' position of the index being one; indeed, for most countries, the index will hover around one due to large numbers of applications and the fact that the source countries, being industrialised economies, will not diverge from overall global patterns, still mostly determined by the developed world, too far in most cases. To make the comparison easier, relative strengths (RTA > 1) are reported in bold font, while fields with a relative weakness (RTA < 1) are in normal font. Where no patent applications exist at all in one field, thus returning an RTA value of zero, the number is grey, indicating that it should be ignored in the analysis.[54] Furthermore, 'n/a' denotes those instances where the patent applications originating in one source country are so few and far in-between that not even the few inward RTAs that could be computed can give any meaningful insight into actual specialisations. However, as all the samples underlying the correlations are very

[54] While it could be argued that no patent applications in a particular field are the proof of a very pronounced weakness (or in the case of inflows, lack of the host country's attractiveness with respect to this technological field), zeroes in this case should be seen as merely resulting from weak overall inflows, often not amounting to more that one or two applications per field and thus not rendering any meaningful indices at all – where this becomes overbearing, 'n/a' was chosen for all fields.

small in most cases, the values can only be considered a rough guidance to the similarity between profiles.

Table 6.8: Comparison between source countries' inward and PCT RTA profiles for Estonia, 1992-1998

	SE/EE	SE/PCT	FI/EE	FI/PCT	DK/EE	DK/PCT	NO/EE	NO/PCT	US/EE	US/PCT	UK/EE	UK/PCT	DE/EE	DE/PCT
A	**1.172**	0.876	0.503	0.576	**1.028**	**1.223**	n/a	0.812	**1.086**	**1.119**	n/a	0.865	**1.005**	0.592
B	**1.288**	**1.384**	**1.621**	**1.102**	**1.181**	**1.008**	n/a	**1.489**	0.484	0.769	n/a	0.902	**1.080**	**1.238**
C	0.857	0.373	0.557	0.510	0.994	**1.039**	n/a	0.447	**1.271**	0.978	n/a	**1.146**	0.965	0.883
D	0.905	**1.847**	0.588	**3.818**		**1.053**	n/a	0.227	0.239	0.754	n/a	0.821	**1.765**	**1.140**
E	0.550	**1.672**	**3.148**	**1.907**	0.894	**1.838**	n/a	**3.984**	0.233	0.575	n/a	**1.118**	**1.502**	**1.055**
F	0.950	**1.499**	**2.294**	0.953	**1.102**	**1.099**	n/a	**1.655**	0.574	0.648	n/a	0.923	0.971	**1.494**
G	0.678	0.716	**1.176**	0.625	0.918	0.537	n/a	0.784	**1.077**	**1.043**	n/a	0.910	0.809	0.865
H	0.571	**1.884**	**4.087**	**3.086**	0.580	0.672	n/a	0.640	0.907	**1.822**	n/a	**1.419**	0.372	**1.639**
corr	-0.22		0.36		0.12		n/a		0.57		n/a		-0.28	

EE = Estonia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 6.9: Comparison between source countries' inward and PCT RTA profiles for Estonia, 1999-2004

	SE/EE	SE/PCT	FI/EE	FI/PCT	DK/EE	DK/PCT	NO/EE	NO/PCT	US/EE	US/PCT	UK/EE	UK/PCT	DE/EE	DE/PCT
A	0.800	**1.076**	0.624	0.569	**1.098**	**1.718**	0.109	**1.057**	**1.109**	**1.201**	**1.224**	**1.098**	**1.120**	0.628
B	0.766	**1.343**	**1.843**	**1.076**	**1.707**	0.918	**6.420**	**1.369**	0.498	0.816	0.814	0.989	**1.304**	**1.479**
C	0.678	0.543	0.533	0.575	0.977	**1.117**	0.393	0.479	**1.058**	0.995	**1.141**	**1.150**	**1.108**	0.936
D	0.660	**1.702**	**2.795**	**7.389**		0.789	**9.040**	0.088	0.372	0.803	0.430	0.802	**2.645**	**1.154**
E	**1.208**	**1.512**	**4.479**	**1.293**	**2.129**	**2.114**	**2.668**	**4.445**	0.128	0.684	0.571	**1.604**	**1.301**	**1.126**
F	**1.330**	**1.391**	**2.775**	0.870	0.836	**1.159**	**4.712**	**1.884**	0.151	0.598	0.896	0.922	**1.379**	**2.082**
G	**1.322**	0.794	**1.052**	0.753	0.792	0.590	0.595	0.826	**1.085**	**1.164**	0.538	0.889	0.445	0.675
H	**2.295**	**1.012**	**1.406**	**1.513**	0.265	0.440	0.332	0.482	**1.226**	**1.033**	0.504	0.817	0.205	0.877
corr	-0.12		0.33		0.72		-0.03		0.93		0.20		0.37	

EE = Estonia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Not surprisingly, the source countries' PCT patenting profiles are much more stable than their inward ones, underlining the countries' position as strongly innovative economies. Most RTAs based on PCT patenting only change in magnitude, very rarely do weaknesses become strengths and vice versa, as in the case of both the UK and Germany, whose performance in the field H (electricity) changes over time from a relative advantage to a disadvantage. As the classification H comprises telecommunication technology, this may be due to an overall shift in worldwide patenting towards the end of the 20th century more than to changes in the domestic economies of the two countries. Indeed, all source countries exhibit worsening performances in this field, which might have to do with a catching up of emerging economies in Asia in the sector of telecommunication. Overall, however, the source countries' PCT patenting profiles are mostly stable.

The same is largely true for the technological profiles the source countries display when it comes to their patenting within Estonia. Where RTA profiles exist for both time periods, not more than two fields change from advantage to disadvantage or the other way around: Denmark (sections E – fixed constructions from weakness to strength and F – engineering vice versa) and Germany (C – chemistry from weakness to strength and F – engineering vice versa) record two of these switches, while the US (H – electricity becomes a strength) and Finland (D – pulp and paper becomes an advantage) only show one. It is interesting to note at this point that seemingly stability of the profile comes with stronger inflows, as the US and Finland contribute significantly to knowledge inflows. Not only do stronger inflows mean generally stronger involvement between Estonia and the respective host country, the ensuing greater stability of the patenting profiles also implies more stable relationships with respect to persistent patenting in the same technological fields – possibly building on ongoing success stories.[55]

The one stark exception is Sweden. While its PCT patenting profile shows nothing out of the ordinary in being very stable, its inward technological specialisations in Estonia are almost reversed in the second time period, with two (A – human necessities and B – logistics) out of the eight fields turning from revealed advantage to disadvantage and four more (E – construction, F – engineering, G – physics, and H – electricity) becoming – in the case of H – marked strengths. It is difficult to fathom why this reversal takes place, given that throughout the strongest sources of inflows are Astra(zeneca), Telia, and Ericsson, often contributing more than half of all knowledge inflows in any one year. Isolating those three firms and attributing their patents very roughly (as there are inevitably many overlaps through multiple classifications) to IPC

[55] Here, Finnish Kemira springs to mind. The firm does not only extend its patents persistently to Estonia, but also has two production subsidiaries in the country (Kemira 2005).

sections A (human necessities, which includes medicines in subclass A61) for Astra(zeneca) and G (physics)/ H (electricity; with most telecommunication patents falling into these two sections) for Telia/ Ericsson patent applications, one sees the combined Telia and Ericsson applications overtake AstraZeneca's in the second time period 1999-2004. While in the earlier period, 66 AstraZeneca patents are filed as opposed to only one Ericsson document, this changes in the later period to 204 and 230 applications, respectively. Ignoring at this point overall inflows, whose composition might influence the value of the Swedish RTAs as much as Swedish patents themselves, it could be argued that Swedish inflows shift in their focus over time, without single persistently active MNEs disappearing. This may be due to the major telecommunication infrastructure projects that were started in the mid-nineties, and which translated into Telia's and Ericsson's intensified activities in Estonia (Högselius 2002). Still, Astra(zeneca) does not disappear (on the contrary, it remains among the strongest single sources of patent applications of all source countries), and other source countries like Germany, the US and Denmark retain their strengths in the field of human necessities, suggesting that despite Sweden's relative turnabout as a whole, the technological field still matters in Estonia in the years 1999-2004.

One observation that meets the eye is that the patterns seem more 'harmonised' in the later time period; indeed, the correlations become almost all positive and stronger than in the earlier period. This is not surprising, as overall knowledge inflows are much greater in the later period.[56] As small numbers tend to distort and/ or exaggerate the RTA values, the years 1999-2004 have to be seen as much more reliable. The relatively high similarity and resulting correlation between US inflows and the country's PCT technological profile confirms that MNEs from the world's largest economy probably do not target Estonia preferentially when they extend patents there, but rather target the

[56] With the aforementioned exception of Sweden.

whole region. Interestingly, this is further supported when the American RTAs as compared to EP patenting are added to the picture.[57] While the coefficient for the second time period is almost exactly the same (0.93 for both international regimes), the correlation between the US inward profile to Estonia becomes strongly positive (0.93) in the first time period as well. With the US being the geographically most distant source country, it is hardly surprising that Estonia is seen more as a part of a wider region than a very distinct entity of its own. Based on this, then, it is rather unexpected that the only country whose inward profile matches to some extent its PCT profile is Denmark, which is a lot closer to Estonia than the US. However, Danish MNEs hardly invest in Estonia compared to MNEs from other countries, so Estonia might represent 'just another foreign country' for them when they extend their own patents. Indeed the correlation between Denmark's inward and international profiles is slightly stronger when measured against the PCT profile (0.72) than when Denmark's EP profile is taken (0.68), which supports the assumption that with respect to Danish interests in Estonia, the Baltic country is in fact rather distant. The look at the two other Baltic States will show that this is actually the case for Estonia alone.

However, it does not seem that all the source countries perceive Estonia as 'far away', as most of the correlation coefficients are relatively low, indicating some overlaps with the source countries' PCT patenting, but without suggesting that their patents are extended to Estonia completely untargeted.

Table 6.10 and Table 6.11 report the same RTA comparison between the source countries' PCT and inward technological profiles when Latvia is the host country that patents are extended to.

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[57] To keep the methodological consistency, EP patenting by any country is not explicitly included in this analysis. However RTAs based on EP patenting are reported in Appendix B.2.2 for completeness. The RTAs of the countries do not differ much between the two international regimes; the correlation between them is very high throughout.

Table 6.10: Comparison between source countries' inward and PCT RTA profiles for Latvia, 1992-1998

	SE/LV	SE/PCT	FI/LV	FI/PCT	DK/LV	DK/PCT	NO/LV	NO/PCT	US/LV	US/PCT	UK/LV	UK/PCT	DE/LV	DE/PCT
A	1.004	0.876	0.648	0.576	1.241	1.223	n/a	0.812	1.249	1.119	n/a	0.865	0.703	0.592
B	1.571	1.384	2.115	1.102	0.755	1.008	n/a	1.489	0.503	0.769	n/a	0.902	1.803	1.238
C	1.023	0.373	0.680	0.510	0.737	1.039	n/a	0.447	1.294	0.978	n/a	1.146	0.870	0.883
D	3.203	1.847	2.128	3.818	1.064	1.053	n/a	0.227	0.173	0.754	n/a	0.821	2.481	1.140
E	0.960	1.672	1.754	1.907	3.070	1.838	n/a	3.984	0.143	0.575	n/a	1.118	1.925	1.055
F	0.404	1.499	2.068	0.953	1.181	1.099	n/a	1.655	0.432	0.648	n/a	0.923	1.504	1.494
G	0.188	0.716	0.686	0.625	0.343	0.537	n/a	0.784	0.947	1.043	n/a	0.910	1.082	0.865
H	0.306	1.884	0.746	3.086	0.373	0.672	n/a	0.640	0.364	1.822	n/a	1.419	0.512	1.639
corr	0.31		0.35		0.96		n/a		0.21		n/a		0.11	

LV = Latvia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 6.11: Comparison between source countries' inward and PCT RTA profiles for Latvia, 1999-2004

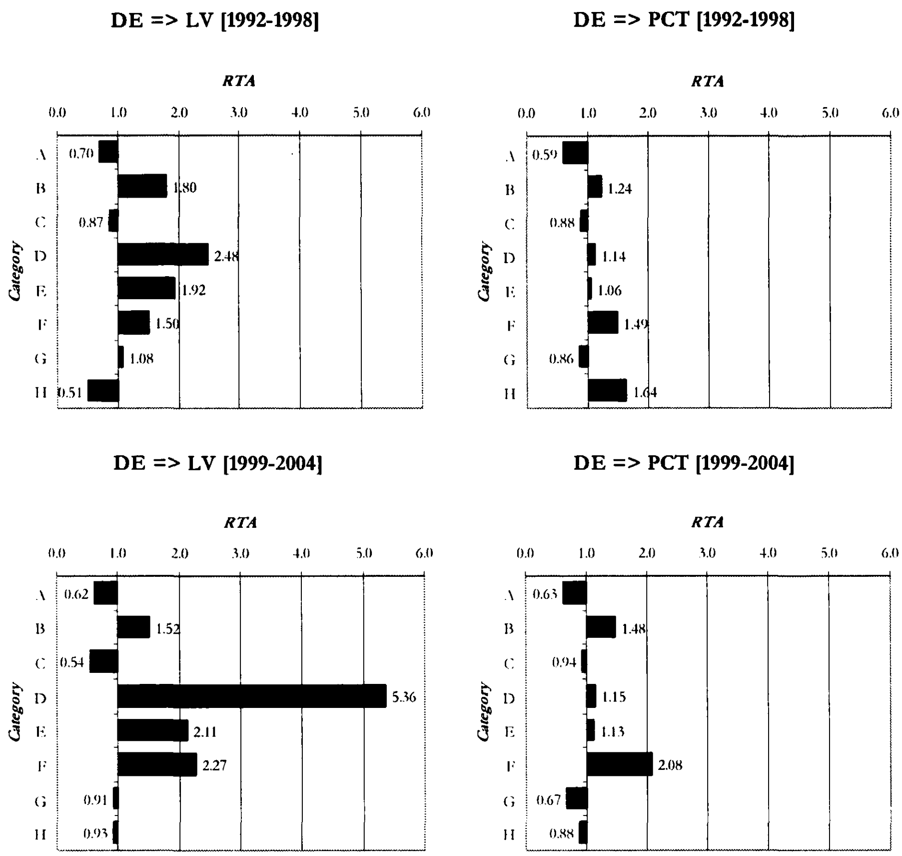
	SE/LV	SE/PCT	FI/LV	FI/PCT	DK/LV	DK/PCT	NO/LV	NO/PCT	US/LV	US/PCT	UK/LV	UK/PCT	DE/LV	DE/PCT
A	0.827	1.076	0.890	0.569	1.447	1.718	n/a	1.057	1.477	1.201	n/a	1.098	0.624	0.628
B	0.616	1.343	0.663	1.076	1.078	0.918	n/a	1.369	0.243	0.816	n/a	0.989	1.521	1.479
C	0.282	0.543		0.575	0.494	1.117	n/a	0.479	1.627	0.995	n/a	1.150	0.542	0.936
D		1.702	7.011	7.389		0.789	n/a	0.088	0.642	0.803	n/a	0.802	5.361	1.154
E	3.851	1.512	2.765	1.293	2.246	2.114	n/a	4.445	0.063	0.684	n/a	1.604	2.114	1.126
F		1.391	4.462	0.870	1.813	1.159	n/a	1.884	0.051	0.598	n/a	0.922	2.275	2.082
G	2.486	0.794		0.753		0.590	n/a	0.826	0.163	1.164	n/a	0.889	0.910	0.675
H	2.250	1.012	1.212	1.513		0.440	n/a	0.482	0.333	1.033	n/a	0.817	0.927	0.877
corr	-0.04		0.81		0.86		n/a		0.53		n/a		0.36	

LV = Latvia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

In Latvia's case, it is probably the earlier time period, 1992-1998, in which the inward RTAs and the resulting correlation coefficients are more reliable. Unlike Estonia, the development of knowledge inflows in Latvia does not experience an overall steady growth, but has its peak in the number of patent applications in the earlier period.

Again, Denmark exhibits a high similarity (corr = 0.96) between its two technological profiles, despite a much higher relative involvement in Latvia through FDI. This could be partly due to Denmark's being what Lundvall (1992) terms a low-tech NIS, where innovation itself is not necessarily incremental or low-key, but happens in low- or medium-tech sectors. More generally, Latvia presents a much more mixed picture that Estonia. However, this is partly due to relatively extreme RTA values in the inward profiles, which are based on smaller and more volatile numbers of patent applications. Indeed Germany's inward profile for instance is not overly dissimilar from its PCT one in its general shape, as Figure 6.3 illustrates:

Figure 6.3: German RTA profiles: in Latvia and the PCT regime, both time periods



Only the fields G (physics) and H (electricity) have opposite qualities in the earlier time period (in the later one, they are identical), the strengths and weaknesses in the remaining six IPC sections that make up the profile match have the same qualities. It is rather the magnitude of these revealed advantages and disadvantages that distorts the correlation coefficient. Germany's two technological profiles are in fact, like most source countries' respective ones, remarkably similar. This suggests that, while a part of the patents extended to Latvia (and the two other Baltic States) is indeed an untargeted knowledge inflow, i.e. they are part of a more general 'push' from source countries towards international protection of cutting-edge knowledge. But the differences *within* the patterns, that is the actual magnitude of specialisations in particular fields, hints to other factors that influence the decision to take out patents in Latvia, characteristics of the host country itself, namely the gradual emergence of relevant skills and a more sophisticated home market. Interestingly enough, the strongest and most persistent German applicants for Latvian patents are on the whole pharmaceutical and chemical MNEs – whereas both in the IPC fields A (human necessities, including medicines) and C (chemistry) Germany's patenting profile in Latvia exhibits revealed disadvantages. This may be explained by the possible motives for extending patents to Latvia – countries in an earlier stage of the IDP (or TDP) will not be targeted for their own abilities, but FDI and trade and thus IP protection will be mostly market-seeking (Dunning and Narula 1996). As the following chapter will demonstrate, Latvia's own abilities in the field of life sciences might not act as a magnet for industrialised countries' MNEs when they extend their patents to the country. This might also – in addition to Ghauri's and Holstius's (1996) claim of initial enthusiasm evaporating – explain to some extent why knowledge inflows trail off after 1997: a patent guarantees the monopoly to the product or process for 20 years; if the extension of existing patents seeks merely to secure markets, all that is needed is an early push for it without any later development.

Lithuania receives the weakest knowledge inflows of all three Baltic States, which is itself an indicator of its attractiveness for foreign knowledge. With several gaps (or rather zeroes) in the data, once broken down by IPC section, the inward RTAs of all source countries have to be regarded as of limited reliability. In the context of this analysis, they are taken therefore as mere indicators of potential specialisations rather than a precise representation of relative performance. The comparison of the source countries inward and PCT RTAs, where they can be computed at all, are reported in Table 6.12 and Table 6.13 below.

Table 6.12: Comparison between source countries' inward and PCT RTA profiles for Lithuania, 1992-1998

	SE/LT	SE/PCT	FI/LT	FI/PCT	DK/LT	DK/PCT	NO/LT	NO/PCT	US/LT	US/PCT	UK/LT	UK/PCT	DE/LT	DE/PCT
A	**1.065**	0.876	n/a	0.576	n/a	**1.223**	n/a	0.812	1.287	**1.119**	n/a	0.865	0.791	0.592
B	**1.213**	**1.384**	n/a	**1.102**	n/a	**1.008**	n/a	**1.489**	0.624	0.769	n/a	0.902	**1.699**	**1.238**
C	**1.057**	0.373	n/a	0.510	n/a	**1.039**	n/a	0.447	1.268	0.978	n/a	**1.146**	0.856	0.883
D	**2.058**	**1.847**	n/a	**3.818**	n/a	**1.053**	n/a	0.227	0.118	0.754	n/a	0.821	**2.175**	**1.140**
E	0.607	**1.672**	n/a	**1.907**	n/a	**1.838**	n/a	**3.984**	0.232	0.575	n/a	**1.118**	**1.655**	**1.055**
F	0.244	**1.499**	n/a	0.953	n/a	**1.099**	n/a	**1.655**	0.672	0.648	n/a	0.923	0.962	**1.494**
G	**1.090**	0.716	n/a	0.625	n/a	0.537	n/a	0.784	0.900	**1.043**	n/a	0.910	0.410	0.865
H	0.377	**1.884**	n/a	**3.086**	n/a	0.672	n/a	0.640	0.346	**1.822**	n/a	**1.419**	0.849	**1.639**
corr	-0.09		n/a		n/a		n/a		0.11		n/a		0.19	

LT = Lithuania(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 6.13: Comparison between source countries' inward and PCT RTA profiles for Lithuania, 1999-2004

	SE/LT	SE/PCT	FI/LT	FI/PCT	DK/LT	DK/PCT	NO/LT	NO/PCT	US/LT	US/PCT	UK/LT	UK/PCT	DE/LT	DE/PCT
A	0.273	**1.076**	n/a	0.569	n/a	**1.718**	n/a	**1.057**	**1.516**	**1.201**	n/a	**1.098**	0.733	0.628
B	0.710	**1.343**	n/a	**1.076**	n/a	0.918	n/a	**1.369**	0.340	0.816	n/a	0.989	**1.042**	**1.479**
C	0.835	0.543	n/a	0.575	n/a	**1.117**	n/a	0.479	**1.722**	0.995	n/a	**1.150**	0.816	0.936
D	[illegible]	**1.702**	n/a	**7.389**	n/a	0.789	n/a	0.088	**1.053**	0.803	n/a	0.802	**4.307**	**1.154**
E	**3.477**	**1.512**	n/a	**1.293**	n/a	**2.114**	n/a	**4.445**	0.069	0.684	n/a	**1.604**	**1.983**	**1.126**
F	[illegible]	**1.391**	n/a	0.870	n/a	**1.159**	n/a	**1.884**	0.125	0.598	n/a	0.922	**1.282**	**2.082**
G	**2.097**	0.794	n/a	0.753	n/a	0.590	n/a	0.826	0.439	**1.164**	n/a	0.889	0.769	0.675
H	**3.388**	**1.012**	n/a	**1.513**	n/a	0.440	n/a	0.482	0.101	**1.033**	n/a	0.817	0.828	0.877
corr	-0.15		n/a		n/a		n/a		0.49		n/a		0.18	

LT = Lithuania(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

As in the case of Latvia, the values in the earlier time period are slightly more robust, as Lithuania received the bulk of patent applications in the years right after independence. Nevertheless, RTAs can only be computed for three source countries: Sweden, the US, and Germany. The inward specialisations of the former two source countries mirror almost exactly the patterns already seen in Latvia, albeit with different magnitudes. And again, Germany exhibits the greatest congruence between the inward and the international profile, indicating than more often than not, Lithuania is not targeted specifically when patents are extended. However, that these few patents are extended to the country, while the majority of German international patenting is not, hints to a – ever so weak – 'pull' from the country and its neighbours, which experience a similar selection.

What all Baltic States have in common is the manner in which the inward technological profiles develop. While these developments have to be regarded with the same caution as the RTAs in general, most patterns stay remarkably stable over time. For nearly all source country/ host country pairings a few relative strengths in the earlier time period turn into weaknesses in later years (and vice versa), usually the majority of RTAs keep their character. The only stark exception is Sweden, whose inward profile almost reverses. This is interesting insofar, as it suggests that despite many patent applications mirroring general internationalisation patterns at least to some extent, there seems to be more that influences the decision to protect foreign-generated knowledge particularly in the Baltics – the 'pull' factor discussed earlier.

Accordingly, the next section will take a look at how the source countries' inward technological specialisations compared to the patenting profiles of the Baltic host economies themselves.

6.5.1.2 Comparison between Inward and Host Country RTAs

While the motives for MNEs' investment in the Baltic States have been discussed in detail in Chapter 3, it was noted that the motives for extending patents are less clearly identifiable or at least measurable. While Paci, Sassu, and Usai (1997) and da Motta e Albuquerque (2000) explain the different motives for patenting at home and abroad and demonstrate how these differing motives result in different technological profiles, they do not distinguish between different 'modes' of patenting abroad, as this section tries to: applying for a near-universal PCT patent as opposed to specifically filing an application in one or a few targeted economies, like the Baltics. Absorptive capacity in the receiving economy plays a decisive role, as the ability to utilise inflowing knowledge can encourage the building of co-operating networks as well as competition from domestic firms (Zander and Zander 1996). This ability is partly influenced by the technology gap between the source and host countries of knowledge, so to gauge at least indirectly the technological capabilities that the Baltic States have themselves to absorb the knowledge codified in patents from other countries, they have to be able to build on a stock of existing knowledge in their own countries. Likewise, given a sufficient and ultimately matching endowment with the necessary capacity, the Baltic States could seem attractive for foreign knowledge, either for protection from competition there, or to simply transfer workable ideas and inventions there to reap the benefits. In order to get an impression of the extent of possible matches between the host countries' endowment with knowledge (which may just as well derive from Soviet legacy, see for instance Högselius 2002 for the case of Estonia) and foreign knowledge, the Baltics' own technological profiles are compared. As noted earlier, domestic and international technological specialisations can differ significantly, and as a patent does not disclose whether it is targeted at domestic or ultimately international use in the host country, both the Baltics States' domestic and international profiles are taken into account.

The comparison between the source countries' inward and Estonia's own RTA profiles are shown in Table 6.14 and Table 6.15 below. The first column records Estonia's domestic specialisations, i.e. showing in which fields Estonian patent applications with an Estonian priority are particularly strong or weak, whereas the second column shows Estonia's performance in the PCT patent regime, as it was done for the source countries in the preceding section. The inward profiles of the source countries are the same as earlier.

Table 6.14: Comparison between Estonia's RTA profiles and host countries' inward profiles, 1992-1998

	EE/EE	EE/PCT	SE/EE	FI/EE	DK/EE	NO/EE	US/EE	UK/EE	DE/EE
A	0.606	0.778	**1.172**	0.503	**1.028**	n/a	**1.086**	n/a	**1.005**
B	**1.535**	**2.690**	**1.288**	**1.621**	**1.181**	n/a	0.484	n/a	**1.080**
C	0.609	0.707	0.857	0.557	0.994	n/a	**1.271**	n/a	0.965
D	**3.857**	*0*	0.905	0.588	*0*	n/a	0.239	n/a	**1.765**
E	**2.815**	*0*	0.550	**3.148**	0.894	n/a	0.233	n/a	**1.502**
F	**1.929**	**2.174**	0.950	**2.294**	**1.102**	n/a	0.574	n/a	0.971
G	**1.929**	*0*	0.678	**1.176**	0.918	n/a	**1.077**	n/a	0.809
H	**1.624**	*0*	0.571	**4.087**	0.580	n/a	0.907	n/a	0.372
corr with EE/EE			-0.33	0.15	-0.72	n/a	-0.82	n/a	0.67
corr with EE/PCT			0.75	-0.10	0.61	n/a	-0.12	n/a	-0.08

EE = Estonia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 6.15: Comparison between Estonia's RTA profiles and host countries' inward profiles, 1999-2004

	EE/EE	EE/PCT	SE/EE	FI/EE	DK/EE	NO/EE	US/EE	UK/EE	DE/EE
A	0.566	**1.770**	0.800	0.624	**1.098**	0.109	**1.109**	**1.224**	**1.120**
B	**2.309**	0.483	0.766	**1.843**	**1.707**	**6.420**	0.498	0.814	**1.304**
C	0.878	0.617	0.678	0.533	0.977	0.393	**1.058**	**1.141**	**1.108**
D	**1.345**	**2.496**	0.660	**2.795**	*0*	**9.040**	0.372	0.430	**2.645**
E	**2.184**	*0*	**1.208**	**4.479**	**2.129**	**2.668**	0.128	0.571	**1.301**
F	**3.272**	**2.171**	**1.330**	**2.775**	0.836	**4.712**	0.151	0.896	**1.379**
G	**1.772**	**1.647**	**1.322**	**1.052**	0.792	0.595	**1.085**	0.538	0.445
H	0.592	*0*	**2.295**	**1.406**	0.265	0.332	**1.226**	0.504	0.205
corr with EE/EE			-0.06	0.60	0.38	0.48	-0.80	-0.15	0.22
corr with EE/PCT			-0.39	-0.08	-0.51	0.41	-0.18	0.07	0.54

EE = Estonia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

The most interesting observation is the Estonia/ Finland pairing. In the later time period, when knowledge inflows are greater and more stable, and Estonia's own patenting has grown as well, Finland's inward profile corresponds closely with Estonia's domestic one, while it is less similar to the Baltic State's PCT profile. However, it is again the correlation coefficients that suggest so, probably all correlations with Estonia's PCT profile are distorted by Estonia's two gaps (or rather zeroes) in the fields E (fixed constructions) and H (electricity). The IPC section D (textiles, paper) in itself is interesting as well: Possibly based on Estonia's history as a region of paper industry under Soviet rule (Ukrainski and Varblane 2006), this sector performs well both domestically and internationally, with relatively more patent applications than in many other fields. Finland, Norway (based on very small numbers), and Germany all have relative strengths in that field in Estonia as well, while only Finland and Germany have relative strengths there internationally. Sweden shows a relative advantage internationally as well, which in turn does not translate this into a similar strength in Estonia. A similar observation can be made for the field E (fixed constructions), where Estonia exhibits only a domestic strength, which might be due to the simple fact that upgrading the domestic infrastructure necessarily entails some (if only incremental and therefore purely domestic) innovation. All source countries except the UK and the US have positive RTA values, probably caused by strong investment in infrastructure projects. There seems to be indeed a pull for knowledge to be transferred to Estonia, at least to some extent.

The picture for Latvia is different and more complicated, as Table 6.16 and Table 6.17 show.

Table 6.16: Comparison between Latvia's RTA profiles and host countries' inward profiles, 1992-1998

	LV/LV	LV/PCT	SE/LV	FI/LV	DK/LV	NO/LV	US/LV	UK/LV	DE/LV
A	0.854	**1.867**	**1.004**	0.648	**1.241**	n/a	**1.249**	n/a	0.703
B	**1.061**	0.538	**1.571**	**2.115**	0.755	n/a	0.503	n/a	**1.803**
C	0.722	0.424	**1.023**	0.680	0.737	n/a	**1.294**	n/a	0.870
D	0.693	*0*	**3.203**	**2.128**	**1.064**	n/a	0.173	n/a	**2.481**
E	**1.224**	*0*	0.960	**1.754**	**3.070**	n/a	0.143	n/a	**1.925**
F	**1.732**	**1.304**	0.404	**2.068**	**1.181**	n/a	0.432	n/a	**1.504**
G	**1.484**	**1.290**	0.188	0.686	0.343	n/a	0.947	n/a	**1.082**
H	**2.152**	**1.304**	0.306	0.746	0.373	n/a	0.364	n/a	0.512
corr with LV/LV			-0.69	-0.12	-0.20	n/a	-0.34	n/a	-0.39
corr with LV/PCT			-0.63	-0.55	-0.44	n/a	0.50	n/a	-0.75

LV = Latvia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 6.17: Comparison between Latvia's RTA profiles and host countries' inward profiles, 1999-2004

	LV/LV	LV/PCT	SE/LV	FI/LV	DK/LV	NO/LV	US/LV	UK/LV	DE/LV
A	0.867	**2.876**	0.827	0.890	**1.447**	n/a	**1.477**	n/a	0.624
B	**1.274**	0.627	0.616	0.663	**1.078**	n/a	0.243	n/a	**1.521**
C	0.842	0.668	0.282	*0*	0.494	n/a	**1.627**	n/a	0.542
D	0.971	**1.622**	*0*	**7.011**	*0*	n/a	0.642	n/a	**5.361**
E	0.957	0.829	**3.851**	**2.765**	**2.246**	n/a	0.063	n/a	**2.114**
F	**1.255**	**2.469**	*0*	**4.462**	**1.813**	n/a	0.051	n/a	**2.275**
G	**1.251**	0.134	**2.486**	*0*	*0*	n/a	0.163	n/a	0.910
H	**1.280**	0.142	**2.250**	**1.212**	*0*	n/a	0.333	n/a	0.927
corr with LV/LV			0.11	-0.08	-0.19	n/a	-0.77	n/a	-0.08
corr with LV/PCT			-0.51	0.44	0.49	n/a	0.30	n/a	0.23

LV = Latvia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

The complication that arises lies in the nature of the data. The details of knowledge generation, as opposed to the inflows, will be examined in the following chapter, but PCT patenting for Latvia follows an entirely different trend than knowledge inflows and domestic patenting. Unlike patent applications in Latvia with a foreign priority, and to a lesser extent entirely domestic patenting, the number of PCT applications that originate in Latvia grows over time, while the two other groups of applications decrease in size in the later years. So while the comparison between inflows and Latvian domestic patenting is more robust in the first time period, Latvian PCT patenting is more steady in the second period (as the disappearing gaps prove), but cannot be confidently matched with the two former groups.

In the years 1992-1998, the technological profile from Germany mirrors the Latvian domestic one most closely (despite the negative correlation coefficient of -0.39, the actual pattern is actually similar except for sections D and H), which allows the tentative assumption that there are features of the Latvian economy that attract patents from Germany, or that there is at least the possibility that knowledge originating in Germany finds a somewhat welcoming environment. However, this does not explain the fall in those patent applications in the later years, when only half of the specialisations of German inflows match Latvian domestic ones, and the German profile seems to settle between the two Latvian ones. No single field sticks out as in Estonia, where relative strengths in inflows from most countries match a corresponding strength in Estonian patenting. Indeed, sometimes the exact opposite seems to be the case. In the earlier period, all source countries except the US exhibit a specialisation in their knowledge flows to Latvia in the sector D (textiles and paper), while Latvia records a weakness domestically and no PCT patent applications in that field at all. Likewise, Latvian patenting, both domestically and internationally, is concentrated in the technological field H (electricity), whereas all source countries with large enough knowledge inflows exhibit pronounced weaknesses in that very field. Given the trends in the later period, it is not surprising that the picture becomes a lot less clear, leading to the overall conclusion that Latvia obviously does not have (or has not developed yet) the absorptive capacity or even innovative environment that attracts targeted knowledge flows into particular sectors. Patent extensions might, on the contrary, target domestic markets, with the aim of mere arms-length trade, rather than deeper involvement. This would then once again support the assumption that Latvia is less attractive for in-depth MNE involvement through FDI (whether production or, at a later stage of the IDP, even R&D), but only for the straightforward protection of products to secure markets – for which one initial effort of patenting would be enough. It might also be the case, however, that Latvia is still at an earlier stage of the IDP than its neighbour, and that – in accordance with the findings presented in Chapter 5 – it may be trade, rather than FDI, that should be linked to knowledge inflows here, as Dunning, Kim, and Lin (2001) and the proponents of the Scandinavian school of internationalisation propose.

The picture is even less conclusive when Lithuania is concerned, for which the comparisons are presented in Table 6.18 and Table 6.19.

Table 6.18: Comparison between Lithuania's RTA profiles and host countries' inward profiles, 1992-1998

	LT/LT	LT/PCT	SE/LT	FI/LT	DK/LT	NO/LT	US/LT	UK/LT	DE/LT
A	0.774	**1.167**	**1.065**	n/a	n/a	n/a	**1.287**	n/a	0.791
B	0.935	*0*	**1.213**	n/a	n/a	n/a	0.624	n/a	**1.699**
C	0.831	**1.061**	**1.057**	n/a	n/a	n/a	**1.268**	n/a	0.856
D	0.869	*0*	**2.058**	n/a	n/a	n/a	0.118	n/a	**2.175**
E	**1.369**	*0*	0.607	n/a	n/a	n/a	0.232	n/a	**1.655**
F	**1.403**	**3.261**	0.244	n/a	n/a	n/a	0.672	n/a	0.962
G	**1.874**	**1.612**	**1.090**	n/a	n/a	n/a	0.900	n/a	0.410
H	**1.541**	*0*	0.377	n/a	n/a	n/a	0.346	n/a	0.849
corr with LT/LT			-0.51	n/a	n/a	n/a	-0.25	n/a	-0.46
corr with LT/PCT			-0.42	n/a	n/a	n/a	0.46	n/a	-0.56

LT = Lithuania(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 6.19: Comparison between Lithuania's RTA profiles and host countries' inward profiles, 1999-2004

	LT/LT	LT/PCT	SE/LT	FI/LT	DK/LT	NO/LT	US/LT	UK/LT	DE/LT
A	0.916	**2.655**	0.273	n/a	n/a	n/a	**1.516**	n/a	0.733
B	**1.250**	*0*	0.710	n/a	n/a	n/a	0.340	n/a	**1.042**
C	0.810	0.411	0.835	n/a	n/a	n/a	**1.722**	n/a	0.816
D	0.822	*0*	*0*	n/a	n/a	n/a	**1.053**	n/a	**4.307**
E	**1.113**	*0*	**3.477**	n/a	n/a	n/a	0.069	n/a	**1.983**
F	**1.300**	**4.342**	*0*	n/a	n/a	n/a	0.125	n/a	**1.282**
G	**1.070**	0.824	**2.097**	n/a	n/a	n/a	0.439	n/a	0.769
H	0.983	*0*	**3.388**	n/a	n/a	n/a	0.101	n/a	0.828
corr with LT/LT			0.06	n/a	n/a	n/a	-0.77	n/a	-0.29
corr with LT/PCT			-0.51	n/a	n/a	n/a	0.02	n/a	-0.26

LT = Lithuania(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

As in Latvia, the trends of knowledge inflows and knowledge generation take opposite directions, which makes, due to even smaller numbers underlying the RTAs, any interpretation of the data difficult. Furthermore, hardly any patterns, whether 'positive', i.e. strengths meeting strengths and vice versa, or 'negative', as in Latvia's case, where strengths in inflows are met by weaknesses in the host country, can be discerned. In the earlier time period, the three source countries all exhibit relative weaknesses in the fields F (mechanical engineering, lighting, heating, weapons, blasting engines or pumps) and H (electricity), which are met with a domestic strength in Lithuania (but no PCT applications in class H). Given the small numbers, it cannot even be said that Lithuania seems to have little to offer with respect to knowledge-based 'pull' factors, particularly the knowledge inflows appear to be more or less random – a finding also partially confirmed in the preceding chapter.

This randomness could be part of the explanation for the fall in knowledge inflows to Latvia and Lithuania, after an initial surge in the early years of independence: A technology gap between them and the source countries which is too large, caused by the failure to adapt to the challenges that came with patent extensions or an insufficient stock of indigenous knowledge preserved from the Soviet era, may have cooled initial enthusiasm in the form of early knowledge flows. Estonia, on the contrary, seems to have done better, although it, too, is still in an early stage of accumulating knowledge and subsequently absorbing and utilising knowledge that flows in from the source countries.

6.6 Conclusions

The present chapter sets out to provide a detailed analysis of the knowledge inflows from selected source countries to the Baltic States. After reducing the sample of source countries to the most relevant ones, the absolute size and development over time of their knowledge flows to the Baltics is provided. After that, an analysis of the institutional base of the patenting as well as of the technological specialisations of the patenting activities both within the Baltics themselves and within the PCT system are conducted, to gain an insight of the motives for extending foreign patents to the Baltic rim.

Several rather intriguing findings emerge. As already seen in the preceding chapter, the three Baltic States are not a homogenous region with respect to the attraction of foreign-generated knowledge. Estonia started more slowly than Latvia and Lithuania, receiving fewer patent applications from abroad in the early years of independence, but unlike the other two countries, which experienced sharp drops in inflows in the later years, managed to sustain an almost continuous growth of these inflows.

It comes as no surprise that the patents extended to the Baltic States are predominantly corporate patent applications; however, the institutional base does differ between source countries and the host economies. Again, it is Estonia that appears to be most successful in attracting persistent patenting by major players, particularly from Sweden and Germany, two source countries relatively close by. Smaller source countries tend to have a more homogenous field of applicants, whereas the Anglo-Saxon countries, the UK and the US, have the most diverse knowledge flows to the Baltic rim with respect to the type as well as the nationalities of the applicants. On the other hand, only relatively little can be said about the concentration of the inflows (as the source countries' home setup is unknown, but will be predominantly corporate patenting (Radošević and Kutlača 1999) – Sweden and the US exhibit the most concentrated knowledge flows. Finland has the least concentrated ones, on the other hand, which could be rooted in a number of smaller firms extending their patents to Estonia in particular, who may perceive Estonia as 'not quite abroad'. This gives support to the assumption that proximity matters greatly when knowledge is transferred across country borders, as already supported by the previous chapter's findings with respect Finland.

Turning to the technological profiles of patenting activities around the Baltic rim, several points can be noted. While all three Baltic States seem to receive a share of the knowledge inflows in the form of indiscriminate international extension of foreign patents, Estonia seems to be the one host country that manages best to also attract patents specifically targeted at its economy. Obviously building on past strengths and extreme openness, the country has the closest matches between its own patenting profile and that of inflows coming from abroad, suggesting the existence of factors that pull knowledge into the country. Furthermore, it is the source countries closest to Estonia, Finland and Sweden, which seem to have the most targeted knowledge flows to the country, while with growing distance the knowledge flows become less targeted, thus highlighting the hypothesised importance of proximity for knowledge flows.

Overall, Estonia is the most successful of the three Baltic States to attract knowledge into the country. However, if this knowledge can be fully absorbed and translated into a domestic innovative achievement, remains to be seen. At several points, the issue of actual knowledge transfer was raised. In this chapter, the issue is addressed only indirectly through the analysis of the technological profiles of host and source countries. The following chapter takes up the theme and provides an analysis of what happens inside the Baltic States with respect to the generation of knowledge, based on the knowledge received from the source countries, and if – and how – the transformation from a centrally planned to a western, knowledge-driven economy takes place.

CHAPTER 7

PATENTING DYNAMICS IN THE BALTIC STATES

7.1 Introduction

Examining the knowledge inflows to the Baltic States, as the preceding two chapters have done, is only one side of the analysis. The aim of the overall study is to provide a comprehensive examination of the Baltic States' development towards knowledge-driven economies since their independence. Following the considerations presented in Chapter 3 once more, it is crucial that the Baltic States do not only develop some ability to attract foreign-generated knowledge, but also the capacity to absorb and accumulate it, and subsequently start generating their own, indigenous, knowledge from the basis of the knowledge stock built through learning and upgrading.

So, while the sample of source countries remains unchanged from the last chapter, the focus shifts from knowledge flowing into the Baltic States to knowledge generated within their borders (i.e. all patent applications that claim priority in Estonia, Latvia, or Lithuania). For the larger part of this chapter, the 'destination' of the knowledge (i.e. whether it remains a domestic patent application or is eventually extended across borders) is not considered, as it is inventive activity itself that is examined. Only in section 7.2.2 and the last part patent applications whose codified knowledge originates in the

Baltic States is split into purely domestic and international (PCT) ones, to distinguish between the excellence component in the whole inventive effort in the region.

With respect to organisation, the chapter broadly follows the structure of the preceding one. Section 7.2 examines knowledge generation in absolute terms and compares that with the knowledge inflows from the selected source country to get an idea of the share of indigenous patent applications in relation to knowledge inflows from abroad.

After that, the institutional composition of knowledge generation in the Baltic States is once again the focus of the analysis in section 7.3. The shares of the different types of applicant are monitored over time, to capture the development from a traditional, Soviet-led S&T system towards a market-driven one. Again, the actual applicants will be identified, particularly those who are not of Baltic nationality, to establish whether foreign entities that patent inventions made within the Baltics are linked, or indeed identical to, sources of patent applications that originate elsewhere. It serves also to identify persistent, vigorous, and also internationally competitive innovators within the systems. At this point, the distinction between purely domestic applications and those aimed at the PCT system is made to identify the internationally competitive knowledge produced in the Baltics.

In order to identify the roots of this excellence component, the citations that these PCT patent applications, which originate in the Baltics, rest upon is presented in section 7.4.

The last part of the analysis focuses, as the preceding chapter, on technological specialisations. The technological characteristics of the knowledge created in the Baltic States are again compared to the technological profiles of the source countries on knowledge inflows, both with respect to their knowledge inflows and PCT patenting.

Similar to the preceding chapter, the comparison is used to examine the influence of foreign-generated knowledge on Baltic development by assessing whether the Baltic States develop the same or similar specialisations as the source countries, i.e. if the Baltic States are 'following the lead' of the source countries.

The last section summarises the findings and concludes.

7.2 Knowledge Generation vs. Knowledge Inflows

7.2.1 Domestic Patent Applications in the Baltic States

Patent applications in the Baltic States whose codified knowledge originates outside the countries naturally form only one part of the whole population of Baltic patent applications. To obtain a complete picture of the patenting dynamics in the countries and whether the assumptions of Ozawa's (1996) TDP model hold in the case of the Baltics, a closer examination of domestic patenting activities, both by domestic and foreign subjects, is needed as well. Figure 7.1 to Figure 7.3 illustrate the volume of these activities for the three Baltic States in comparison to the knowledge inflows reported in the preceding chapter. The graphs depict all patent applications filed in each state: those that claim a domestic (Estonian, Latvian, or Lithuanian, respectively) priority (i.e. domestically generated patents), those with a Nordic (Swedish, Finnish, Danish, or Norwegian) priority number, and finally those that are based on priority documents from the three large Western economies (US, UK, and Germany) (the latter two groups being the aforementioned knowledge inflows).[58]

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[58] The applications claiming a foreign priority, whether Nordic or Western, are the inflows presented in the preceding chapter.

Figure 7.1: Patent applications in Estonia, broken down by priority number, 1992-2004

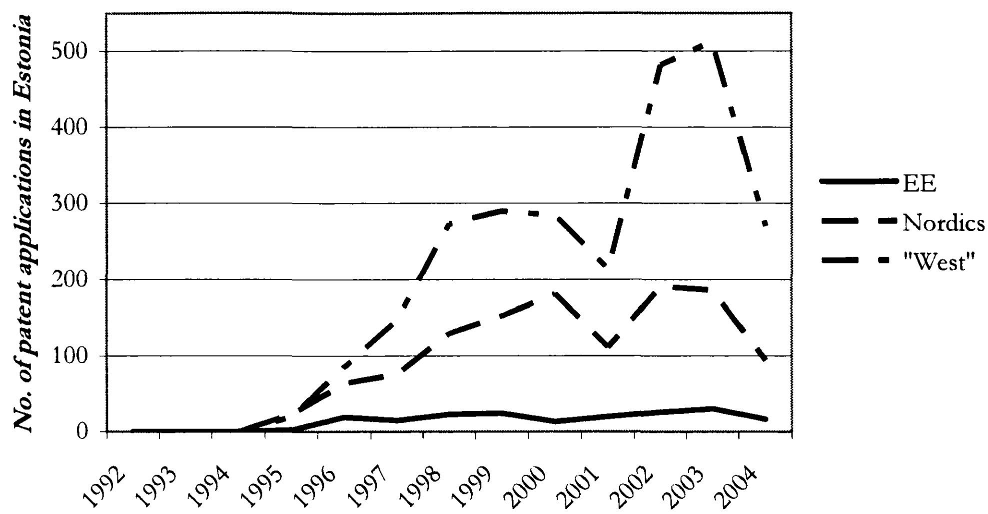


Figure 7.2: Patent applications in Latvia, broken down by priority number, 1992-2004

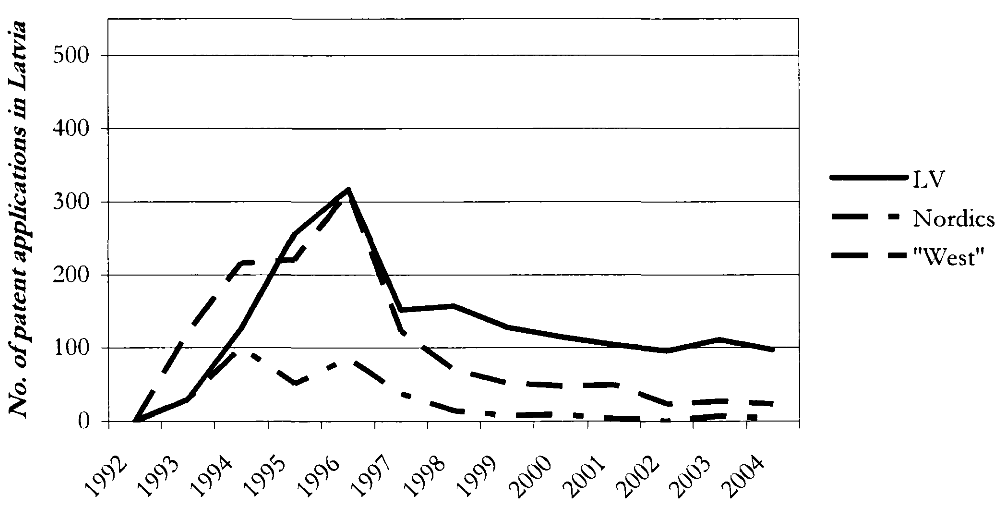
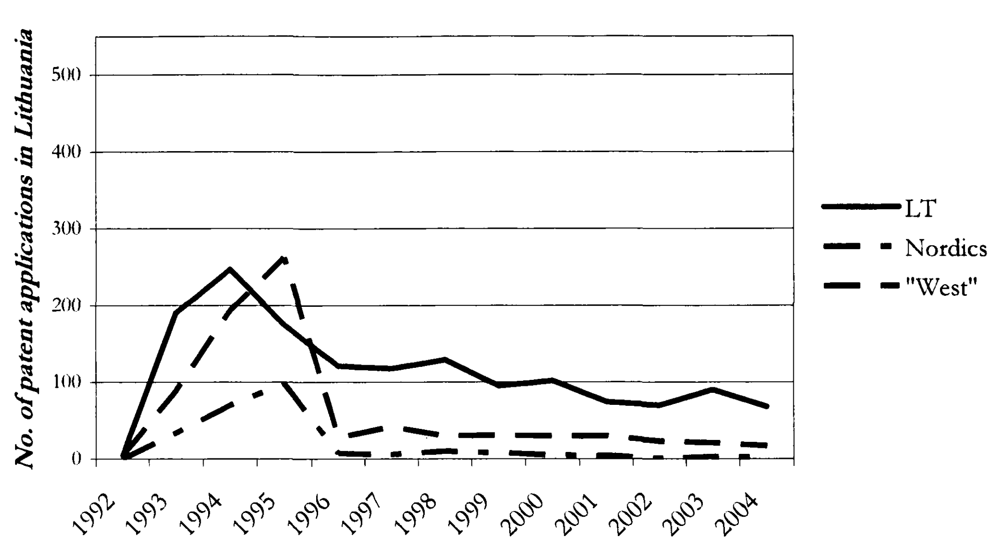


Figure 7.3: Patent applications in Lithuania, broken down by priority number, 1992-2004



Once again, the difference between Estonia and the two other countries is striking: The vast majority of patent applications within Estonia are based on a foreign priority, with Estonian priority numbers never making up more than 10% (in 1996) of all applications and usually being less than 5%.[59] The large share of Western-based patent applications is based on the strong knowledge inflows from the US, the overall largest contributor, which accounts for roughly 30% of all applications in Estonia. Of the Nordic countries, Sweden predictably makes the largest contribution to applications, with its share hovering around a fifth. It is, however, the share of patent applications originating in Estonia itself (i.e. patents whose codified knowledge originates in the country) that is surprising. Rather than increasing its share over time (and thus implying the development of national innovative capacity), the absolute numbers rise slowly to a maximum of 30 applications in 2003, while the share of overall patenting activity falls almost continuously.

[59] Realistically, these shares are even smaller, as they are only compared to selected knowledge inflows (those from the selected sources, the Nordic countries, the UK, the UK, and Germany), rather than all inflows.

The picture is almost the opposite in Latvia and Lithuania. Unlike Estonia, they seem to rely more on indigenous rather than foreign knowledge. In both countries, patent applications with domestic priorities follow the development of knowledge inflows, with a surge at the beginning of transformation and a subsequent reduction in numbers, but they never fall to the levels of the inflows, outnumbering patent applications originating elsewhere. Indeed, the share of patent applications of domestic origin grows from 12% in 1993 to roughly three quarters in the later years of transition in Latvia and is relatively stable above 60% in Lithuania (with one dip in 1994/5).

Obviously Estonia relies on foreign knowledge much more heavily than the other two Baltic States, where patent applications with a domestic origin outweigh those from abroad significantly. This effect is exacerbated by the observation that not only does Estonia receive much higher inflows in absolute terms, but the domestic patenting activities on the other hand are much lower. However, Estonia is the smallest of the Baltic States, so in order to avoid distorting the picture, domestic patent applications (or rather those patent applications which claim a domestic priority) have been calculated as applications per 1000 inhabitants and are presented in Table 7.1 below:

Table 7.1: Patent applications with a domestic priority per 1000 inhabitants in the Baltic States

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
	Patent Applications	0	0	0	2	19	15	23	24	13	20	26	30	16
Estonia	Population	1,533,091	1,494,128	1,462,514	1,436,634	1,415,594	1,399,535	1,386,156	1,375,654	1,369,515	1,364,101	1,358,644	1,353,557	1,349,290
	Pat.Apps./ 1000pop	0.000	0.000	0.000	0.001	0.013	0.011	0.017	0.017	0.009	0.015	0.019	0.022	0.012
	Patent Applications	0	29	126	256	317	152	157	128	115	104	96	111	97
Latvia	Population	2,614,338	2,563,290	2,520,742	2,485,056	2,457,222	2,432,851	2,410,019	2,390,482	2,372,985	2,355,011	2,338,624	2,325,342	2,312,819
	Pat.Apps./ 1000pop	0.000	0.011	0.050	0.103	0.129	0.062	0.065	0.054	0.048	0.044	0.041	0.048	0.042
	Patent Applications	4	190	247	175	121	118	129	95	102	74	70	90	68
Lithuania	Population	3,700,114	3,682,613	3,657,144	3,629,102	3,601,613	3,575,137	3,549,331	3,524,238	3,499,536	3,481,292	3,469,070	3,454,205	3,435,591
	Pat.Apps./ 1000pop	0.001	0.052	0.068	0.048	0.034	0.033	0.036	0.027	0.029	0.021	0.020	0.026	0.020

(Source: Eurostat)

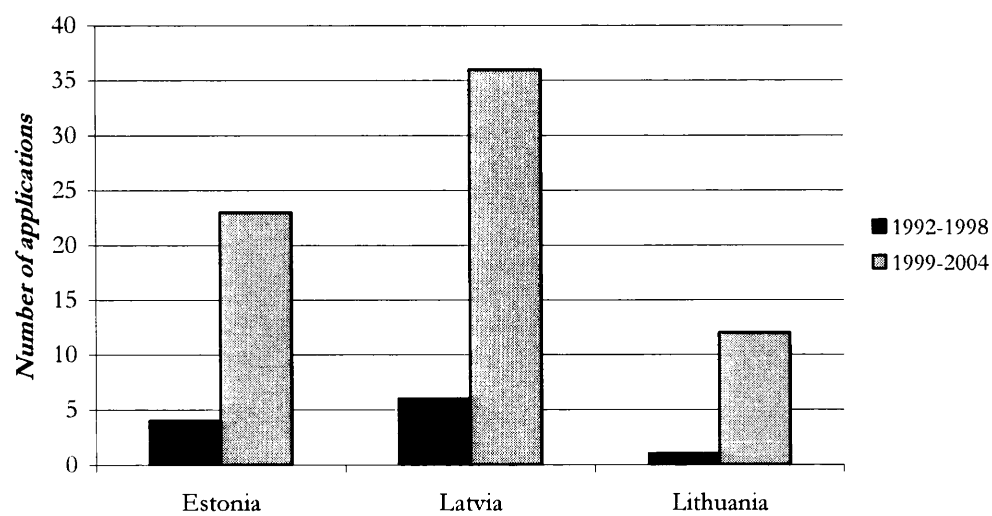
The impression that Estonia relies far more on foreign inflows of knowledge is reflected in its own innovative performance at home – domestic patent applications per population are lower than in Latvia and Lithuania throughout the time period under consideration. While Latvia records up to 0.129 applications per 1,000 inhabitants with a domestic priority in 1996 and Lithuania a maximum of 0.068 in 1994 (although the number falls significantly in later years), Estonia never records more than 0.022 applications per 1,000 population in 2003 and most of the time hovers around only 0.014. So, while Estonia shows the lowest level of indigenous innovative activity, it still manages to attract the largest knowledge inflows by far. This is somewhat counterintuitive, as it has been argued previously that in order to attract foreign knowledge in the form of patents, some absorptive capacity in the shape of innovative activity is needed to create a 'readiness' for the incoming knowledge (Cohen and Levinthal 1989). At this point, where only domestic patent applications are concerned, it is impossible to judge the quality of the knowledge embodied in them, and it seems the sheer number of patents as the hard output of innovative effort fails as an indicator of absorptive capacity here. If absolute numbers of domestic applications were a sign of attractiveness, Latvia should attract far greater knowledge inflows that Estonia. It is obvious, however, that Estonia is more successful in attracting foreign knowledge and seemingly depends more on it, given its lower level of absolute patenting. The studies on Estonia's forest and wood (Ukrainski and Varblane 2006) and telecommunication (Högselius 2002) sectors partly support this by both stating that Estonian companies will rely on foreign knowledge wherever available and are mostly not past the adaption phase themselves, meaning, they hardly innovate actively. Furthermore, Männik, Hannula and Varblane (2006) find that subsidiaries' performance in CEE is linked to the strengths of their technological links with the MNE, i.e. depends on technology transferred from the corporate parent.

It might also be that it is the quality, rather than the quantity of domestic patenting activities that makes the country a more attractive target for extending foreign-generated knowledge there. Two measures to assess this quality are used in the following: the rate of international patent applications that originate in the Baltic States, and the institutional base of all knowledge generated there – i.e. the shape of their national innovation systems.

7.2.2 *International (PCT) Patent Applications from the Baltic States*

With respect to knowledge generated within a country, it is that component of it which is relevant for world markets that distinguishes a country's international competitiveness. As noted by Paci, Sassu, and Usai (1997), foreign patenting represents a more accurate measure of the excellence component of the national technology system. In Figure 7.4, applications for 'world patents' (PCT) claiming a priority in one of the three Baltic States are presented.

Figure 7.4: PCT patent applications with a Baltic Priority



In the 1992-1998 time period, only a tiny number of PCT applications have their origins in the Baltic States. This is understandable, given that the Baltic countries joined the WIPO and Paris Conventions and the PCT between 1992 and 1995 (WIPO 2004); thus it seems logical to expect that patenting took some time to develop. Furthermore, as former Soviet republics, the transition to a western system of intellectual property protection was a profound change that took time to settle in the inventors' mindset.

After 1999 the situation has somewhat improved, although international patenting is still weak in the Baltic countries – especially in Lithuania. However the numbers have grown enough to allow a more in-depth analysis, which will be done later in this chapter. What is noticeable, though, is the enormous increase itself of applications over the previous period. That in itself shows a movement towards greater integration into the international patenting community, an opening up of the nascent Baltic knowledge economies and is in part compensating for the fall in absolute numbers witnessed in Latvia and Lithuania.

7.3 The Institutional Base of Knowledge Generation in the Baltic States

7.3.1 The Composition of Patent Applications

The proportions of the different types of applicant are monitored over time to analyse not only the amount of knowledge that originates in the Baltics, but also who actually generates this knowledge. As argued by Radošević and Kutlača (1999) who studied US patenting by CEE countries, knowing the institutional basis of patenting activity is crucial for understanding a country's prospects for catching up. They add that as a country becomes more market-oriented, there is an increasing share of knowledge created within the country by foreign firms, while the share of extra-mural organisations (industrial institutes, Academies of Sciences, and universities) decreases. Archambault (2002) highlights the differences between individual and institutional inventors, with institutional patents being a more robust indicator of a country's technological competitiveness.

To take a closer look on the institutional shape of patenting activities in the Baltic States, both purely domestic and international patent applications are again combined, as well as those that are, strictly speaking, neither, but appear as European, US, or other non-Baltic, non-PCT applications. This is done to take into account that national innovative capacity may develop at home first, before it is translated into internationally competitive knowledge creation. Furthermore, it is possible there are patents whose knowledge originates in the Baltic States but is in fact created by MNE subsidiaries located there (this will be investigated later, when foreign knowledge generation within the Baltics is discussed) and transferred only to the home country of the MNE. To avoid double-counting (a patent can appear with different application numbers resting on one priority once it is extended to different countries or patent regimes), this combined measure of inventive activity takes into account only priority numbers and disregards the actual 'direction' of the final application. Thus, domestic and non-domestic applications are combined, while the focus is purely the origin of patent applications.[60] The applicants are separated into seven categories: domestic firms (DOM), foreign firms (FOR), individual applicants (IND), universities (UNI), Academies of Science and their successors (AcSc), and pure government institutions like ministries (GOV). The last category, 'other' (OTH), contains the few applicants that could not be categorised at all due to a lack of available information.[61] The categories UNI and AcSc, as well as GOV and OTH, have been combined. In the first case, this has been done because several research institutes have been moved during the time under consideration, being attributed to the National Academies of Science in the earlier years and to a university later, or vice versa. Government institutions that are clearly attributed as belonging to the government (rather than Academies of Science or

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[60] The combination of the two kinds of applications does not distort the picture that much, though. Given the small amount of PCT applications as a share of overall patenting, it seems safe to say that in the end, it is domestic patenting that is considered. PCT applications with a Baltic priority will be discussed in due course.

[61] Some applicants could not be identified with certainty. The overwhelming majority of domestic patents in the first half of the time under analysis has been digitalised without English translations and often contains only minimal information, sometimes not even the applicant's name. Assuming that in these cases the applicant is identical with the inventor is mere conjecture, so 'blank' applications have not been categorised.

universities) are very rare, as are applicants that cannot be identified. In order to keep the picture clear, these two categories are merged as well. Figure 7.5 to Figure 7.7 show how the total amount of patent applications that claim priority in either of the Baltic States is distributed among the different types of applicants.

Figure 7.5: Patent applications claiming an Estonian priority, broken down by type of applicant, 1992-2004

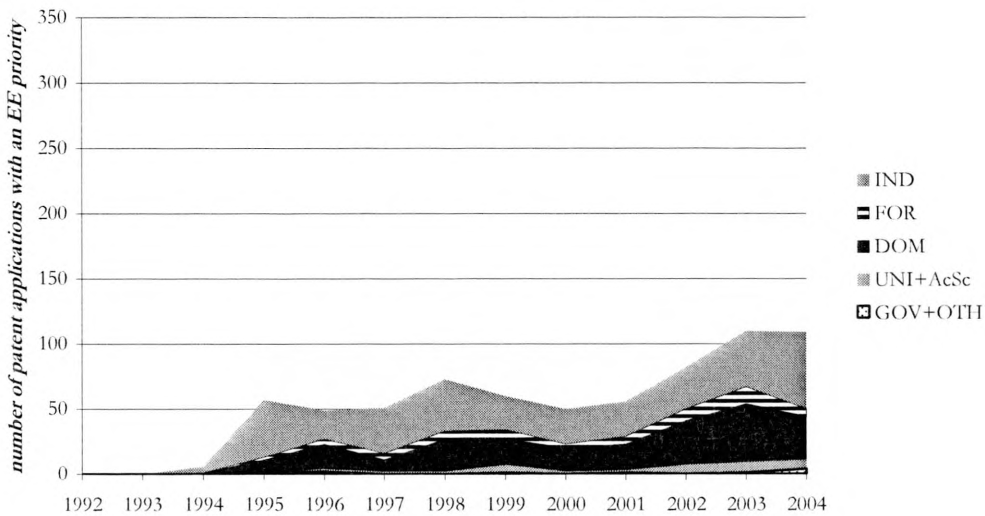


Figure 7.6: Patent applications claiming a Latvian priority, broken down by type of applicant, 1992-2004

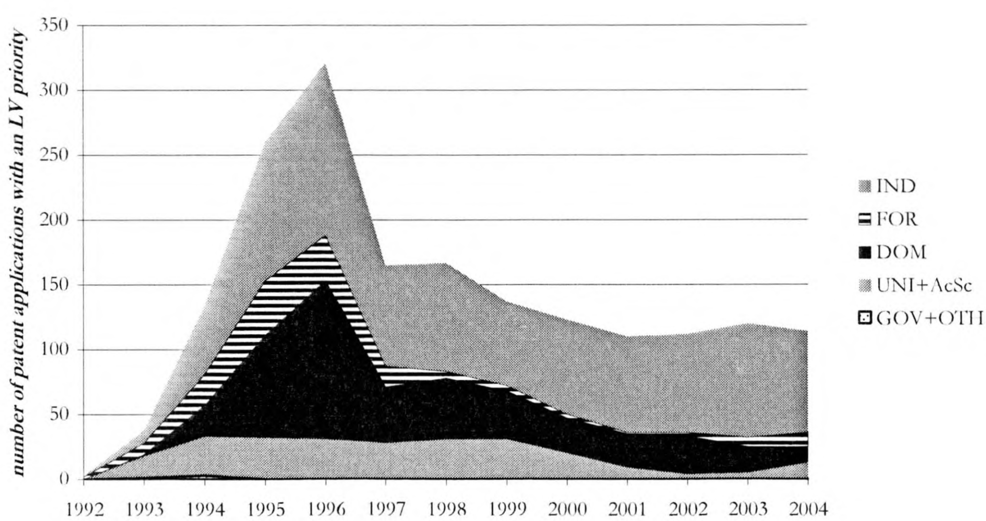
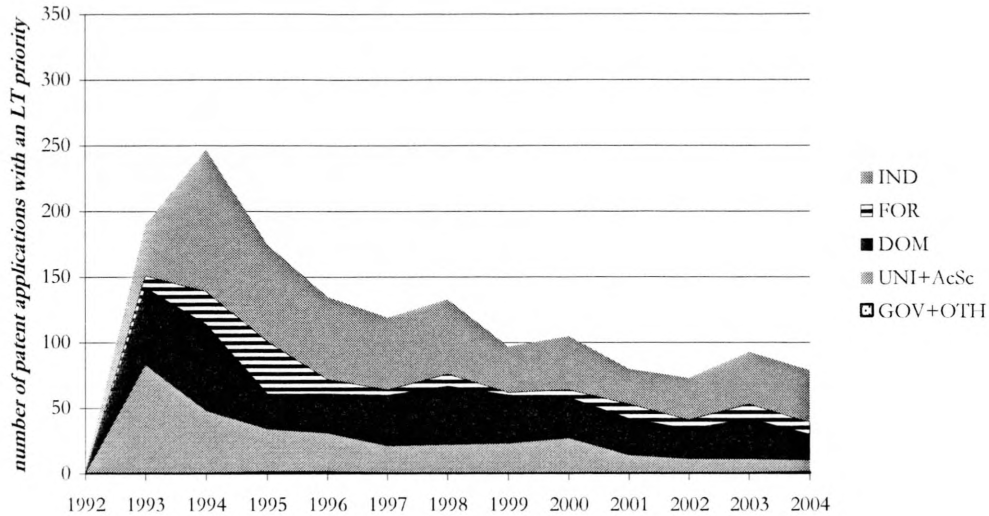


Figure 7.7: Patent applications claiming a Lithuanian priority, broken down by type of applicant, 1992-2004



The institutional basis of the patenting activity is significantly different in each country. Following Radošević and Kutlača (1999) and Radošević (1998), a high share of individual applicants was expected in all three countries, this being a developmental feature of all emerging economies with weak corporate sectors. This is partly due to the Soviet system of IP protection, which favoured individuals to apply for international patents in order to mask government firms and agencies, thus forging a culture of taking out patents individually (while this was predominant in US patenting for political reasons, it might echo to some extent in general patenting). However, compared to the figure for the Soviet Union, where 82% of applicants were individuals in the time leading up to 1994 (Radošević 1998), this figure is low for the Baltics – hovering just below 50% (in single years above that in Estonia) in the first few years of the transition process; this is, of course, for a body of patent applications that stays mainly within the country (although a similar outcome will be shown below, when PCT patenting is analysed). In Estonia and Lithuania, this share of individual patenting has declined slightly since – although the picture becomes distorted once the diverse development of the absolute numbers is taken into account. In Latvia however, individual applications as a proportion of total patenting have been on the rise since 2000, after having experienced their lowest point as early as 1993 at 26%.

As for the development of business (both domestic and foreign) as a driver of knowledge creation within the Baltic States, the emerging picture is once again mixed. While the share of domestic firms generating priority documents in Estonia has almost continuously risen to about 40%, the contribution of foreign firms has stayed quite stable at around 11%. This looks a lot more promising than the situation in Latvia, where foreign applicants generating knowledge within the country have almost disappeared after an initial surge in the earliest year, when foreign applicants contributed the lion's share with two-thirds of all priority documents. Domestic firms generate roughly a quarter (starting from nothing and peaking briefly in 1996 with a 38% share) of all patent applications that originate in Latvia. With absolute numbers falling after 1996 and the share of individual applicants on the rise, Latvia – at least judging by this snapshot – seems to fail to develop a sustainably innovative business community; a notion that the applicant analysis will take further. What sticks out, however, is the share of priority documents being named by the extra-mural organisations. Unlike their Estonian counterparts, they contribute visibly to the knowledge generation within Latvia, their share ranging from 45% in 1993 to usually above 15% in later years (2001-2003 being the exception). In Western economies, this share is much lower, with university patents amounting to only about 4% of all domestic patenting in the US in 1999 (Mowery and Sampat 2005).

The institutional composition of patenting in Lithuania broadly resembles that of Latvia. However, patent applications filed by foreign firms do not only stay stronger in relative, but also in absolute terms in Lithuania. This is to some extent unsurprising, as Lithuania is simply larger than Latvia, with a larger domestic market to service. The analysis of knowledge inflows in the preceding chapter has shown that inflows per head are weaker than in the other two countries, but it still is interesting to note that despite this relatively poor performance, it is Lithuania, rather than Latvia, that manages to sustain domestic patenting done by foreign firms more successfully. It is also notable that as early as 1997, the institutional composition of patenting in Lithuania somewhat stabilises.

While in Estonia domestic corporate applications experience an almost continuous rise in relative terms as opposed to a relative decrease in academic patents (as does, to a lesser extent, foreign patenting), and in Latvia individual patenting regains the strong position of earlier years of transition in the later years (although it never falls even near to western levels), any development in either direction stalls quite early in Lithuania. According to Aidis (2002), Lithuania's transition process can be broadly understood as two distinct phases: an early phase of fast change and resulting turbulence up to about 1994/95, and a later phase of caution and consolidation of early successes and failures, if not a return to outright rigidity with respect to a further push in follow-up reforms. Taking into account the usual lag of at least 12 months between filing and publication of a patent application[62], this breakdown is roughly mirrored in Lithuania's institutional composition of applicants. It would explain the early surge in patenting, both in knowledge inflows and in knowledge generation, as well as the relative turbulence. After that, the situation calms, while patent applications level off, the applicants' composition remains remarkably stable. This is not necessarily a 'good' thing – the transformation towards a more western make-up seems to stall. This might be due to the aforementioned slack in the reform progress and thus formal and informal barriers that domestic firms face (Aidis 2002). On the other hand, while not as promising as Estonia (where both the absolute number of applications rises and the composition of ap-

[62] Plus any delays in the upload to the digitalised patent databases particularly in earlier years of transition, as detailed in Chapter 4.

plicants gradually shifts towards stronger corporate patenting), it seems to be still better than the situation in Latvia, where an initial movement towards more westernised patterns is partly reversed to a more 'Soviet' composition of applicants, with a very high share of individual applicants.

7.3.2 Foreign Applicants

In the context of knowledge generation, and following Radošević and Kutlača (1999) again, it is the patent applications filed by foreign firms that are of the greatest interest, as they are the ones that indicate success in the transition to a market-oriented economy[63]. Given the relatively small number of these applications, it is not surprising that there are not any clear leaders of patenting emerging – the picture is rather unfocused. What is more, particularly in Estonia the leading sources of knowledge inflows (patents extended to the country, rather than being created there) hardly manifest themselves at all. In the whole time since 1992, there is only one patent filed by AstraZeneca, which claims an Estonian priority. This is not overly surprising, as AstraZeneca does not conduct R&D in any Baltic State, but only runs distribution centres (AstraZeneca 2007). The same observation can be made for almost all other firms that contribute significantly to knowledge inflows – if there are any spillovers of their knowledge to the Estonian economy, they can only happen through patents whose embodied knowledge originates abroad. Da Motta e Albuquerque (2000) makes a similar observation for domestic patent applications in Brazil when stating that there is very little persistence in patenting activity in the country. This could be because FDI does not necessarily entail patenting, either because it is not oriented at R&D or transfers knowledge that is too low-key to be patented. What is notable on the other hand, though, is that foreign firms that do generate knowledge inside Estonia quite

[63] The complete list of foreign firms taking out patents in each Baltic State is presented in Appendix B.3.2.

often come from relatively small countries, like Israel, Switzerland, or neighbouring Finland.

The contrast between sources of knowledge inflows and actual knowledge creators within the host countries is starker in both Latvia and Lithuania. During the surge of innovative activity in the early years of transition, many MNEs that contribute to knowledge inflows in both countries actually do also generate some knowledge there, with US pharmaceutical giant Merck generating as many as seven priority documents in Latvia in 1995 (out of a total of 42 foreign-generated applications). Generally, it is pharmaceutical and chemical companies that feature strongly in those years on both countries, the IPC sections A (human necessities, including medicines) and C (chemistry) being the strongest fields of activity. One notable MNE is Richter Gedeon Ltd, a Hungarian multinational. While not overly important as an inventor in the Baltics (it generates only one and two applications in Latvia and Lithuania, respectively, and none in Estonia), it is interesting to note the relative success of a CEE MNE; Richter Gedeon has defended a sizeable market share in former socialist economies after 1990 (Éltető and Antalóczy 2003). However, the picture changes quite radically when overall patent numbers begin to fall and level out. What little patenting activity by MNEs remains is mostly done by relatively diverse firms from varying backgrounds, with no discernible pattern emerging. It almost seems as if large MNEs gave up on both countries in the mid-nineties, again lending support to the idea of two distinct periods of transition and the cooling of MNEs' initial optimism (Ghauri and Holstius 1996).

As said before, with small numbers of patent applications in the Baltic States by foreign firms and few, if any, persistent innovators from abroad generating patentable knowledge in the countries, it is hard to imagine strong spillovers from this foreign knowledge. All three countries started with profound weaknesses into their transition process: research was highly segregated and isolated, and did not answer outside demands in the economy, but was dictated by Soviet decision-making in Moscow (Dyker and Radošević 2001, Radošević 2003). Furthermore, while generally highly educated, the population had very specialised skills, due to the strong separation of specialised subjects, and was thus prone to finding more general learning (as knowledge-driven economies require) from possible MNE flagships difficult (Worldbank 1992a, 1992b, 1993). This way, spillovers would be difficult to facilitate, and while the preceding analysis did not look specifically for them, the seeming reluctance of the Latvian and Lithuanian institutional base to change towards a more typically Western one suggests at least some hindrance or opposition to overall transformation. This is confirmed by the countries' ranking in the World Competitiveness Report, where Latvia and Lithuania are ranked quite low for the item 'FDI as a source of knowledge transfer'.[64] The next section of the chapter therefore takes a closer look at 'harder' evidence of spillovers and examines what internationally competitive patent applications originating in the Baltics actually rest on, in order to determine whether MNE activity is embedded in the host economy or happens isolated from its surroundings.

7.4 Patent Citations in the Baltic States

Patent citations, i.e. the disclosure of prior knowledge on which a patent applications rests, form the most tangible evidence spillovers when dealing with patent data (Jaffe, Trajtenberg and Henderson 1993). As highlighted in Chapter 4, most studies examining this paper trail of inventions rely on large numbers, mostly US patent data collected by the NBER. Thus, econometric analyses can be conducted, mostly on the geographical diffusion of knowledge. This study, however, deals with very small numbers, far too

[64] Latvia ranks 25th (2002/03), 46th (2004/05), and 50th (2005/06), while Lithuania ranks 47th, 39th, and 73rd respectively, as opposed to Estonia's very high 9th, 9th, and 13th place (WEF 2002, 2004, 2005).

small to allow for advanced statistical tools, as only large numbers allow for the elimination of natural bias[65]. Yet the analysis of citations in internationally competitive patent applications originating in the Baltic States can still shed light on some patterns of inventive activity in those countries, if only in a more anecdotal fashion. This narrative may, however, point to some practices when building on (and disclosing) prior knowledge when applying for PCT patents in the Baltic States. Radošević (2003) describes three main motivations in the shaping of post-Soviet Russian S&T policy: the attempt to preserve existing structures, the urge to reform the country's S&T system, and the every-day struggle for the survival of institutions, their budgets, and projects. While the analysis both focuses on a different environment (Russia) and different issues (namely policies and their implementation), it highlights the challenges that economies in transition face with respect to developing and adapting their national innovation systems. Given these motivations, it will be interesting to see if any patterns pointing towards an opening-up (which would possibly entail the citing of foreign more than indigenous knowledge) or a reliance on tried-and-trusted sources of competence (i.e. own or 'traditional' knowledge) emerge. A stronger reliance on what could be termed 'conventionalised' knowledge – i.e. knowledge passed down through Soviet institutions and researchers – would indicate a less open, maybe less reformed innovation system than one where inventors and patentors rely more heavily on foreign patents for their own inventive efforts. Kozlowski, Radošević, and Ircha (1999) find evidence for a persistence of traditional core strengths in CEE countries when analysing academic publications.

To do this, all PCT patent applications with an Estonian, Latvian, or Lithuanian priority number, as reported in Figure 7.4 above, are examined with respect to the prior

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65 Trajtenberg (1990) discusses the 'noise' that the nature of patent citations creates, and which biases findings for small datasets, in some detail. The possible problems and weaknesses that arise when dealing with patent citations are documented in Chapter 4.

knowledge they disclose. Of these cited patents and articles, the applicants/ authors, as well as the nationality of the document (whether by application number for patents or author for articles) is noted. Table 7.2 to Table 7.4 below report summary statistics for the PCT patent applications' citations for each country, while the detailed data tables can be found in Appendix B.4.

Table 7.2: PCT patent applications claiming an Estonian priority and their citations, summary statistics

	Proportion of PCT Applications (%)			Mean Number of Patent Citations			Mean Number of Document Citations			Mean Number of ALL Citations		
	96-98	*99-04*	*96-04*	*96-98*	*99-04*	*96-04*	*96-98*	*99-04*	*96-04*	*96-98*	*99-04*	*96-04*
IND	71.4	50.0	54.1	3.4	3.9	3.8	0.4	0.1	0.2	3.8	3.0	3.9
UNI	28.6	20.0	21.6	2.5	2.5	2.5	2.0	3.7	3.3	4.5	4.6	5.8
DOM	0.0	26.7	21.6	n/a	4.5	4.5	n/a	1.4	1.4	n/a	5.9	5.9
FOR	0.0	0.0	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AcSc	0.0	3.3	2.7	n/a	3.0	3.0	n/a	1.0	1.0	n/a	4.0	4.0
Other	0.0	0.0	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
All	100.0	100.0	100.0	3.1	3.7	3.6	0.9	1.2	1.1	4.0	4.0	4.7

In Estonia, the observations regarding the institutional composition of applicants can be confirmed for PCT patent applications – while the share of individual applicants falls over time, it is still the largest group of applicants, with half of all applications being filed by individuals in the later time period. To begin with, it is indeed only individuals and universities that take out PCT patents; only after 1998 do domestic firms and once the Academy of Science file PCT applications. It is not known, however, how easily individuals employed by a university can take out their own patents, as this is up to the institution in question to regulate.[66] Not surprisingly, the PCT patent applications filed by universities cite – on average – more academic papers[67] than other documents, while individuals and firms rely more heavily on actual patents for their citations. Where citations are made, the majority of patent citations are US patents (53), followed by PCT (24) and Germany (18). Whether these citations are added by the applicant or the

[66] While the data seem to suggest that usually Estonian universities share patents with the inventors by making both the university and the inventors appear as applicants, it cannot be taken for granted that this is the case throughout. Indeed, at least one PCT patent application names an applicant (A. Rozkin in 2004) known to appear as inventor on a university patent as well. Whether this person had left the university by the time this individual application was filed, or whether this is due to the digitalisation process, is unknown. The issue gets even more convoluted for Latvian patents.

[67] Document citations, as opposed to patent citations, are mostly academic papers. However, the odd web site or magazine article makes an appearance as well.

examiner, it stands to reason that international patents are easier to access when prior knowledge is looked for, thus being found more frequently than foreign national patents. It is interesting to note that all but one self-citation are made by university or Academy of Science applications and usually are papers rather than patents. Here, it seems, existing knowledge (which might not have been patentable under Soviet rules) is preserved, as some papers do indeed reach back to the years around independence. On the other hand, little 'official', as in codified, Soviet knowledge is tried to be preserved: Only two Soviet patents are cited in all Estonian PCT applications from 1996 to 2004, plus two US patents by USSR institutions.[68]

While the observations made for the citations lead to the tentative assessment that Estonia is more on a path of gradual restructuring than preserving of its S&T economy, the actual applications suggest otherwise. Not a single PCT patent application is filed by a foreign firm (i.e. an MNE subsidiary in the country). So while Estonian inventors, whether from universities, firms, or individually, seem to rely more on foreign knowledge than domestic one as a starting point for their own inventive efforts, the country as a whole seems only on the way to being attractive for foreign R&D efforts, thus confirming the assertion of Radošević (2004), who finds in his study of CEE's innovation capacities that R&D investment (both domestic and foreign) lags behind the rest of the EU.

Turning to Latvia, once again, the situation is more complicated. Table 7.3 reports the summary statistics for citations made by Latvian PCT patent applications.

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[68] The two US citations are made by Kokk and Köömägi's 1998 patent and the 2003 Academy of Science application.

Table 7.3: PCT patent applications claiming a Latvian priority and their citations, summary statistics

	Proportion of PCT Applications (%)			Mean Number of Patent Citations			Mean Number of Document Citations			Mean Number of ALL Citations		
	93-98	*99-04*	*93-04*	*93-98*	*99-04*	*93-04*	*93-98*	*99-04*	*93-04*	*93-98*	*99-04*	*93-04*
IND	60.0	81.4	75.9	5.0	4.5	4.6	0.3	0.7	0.6	5.3	5.3	5.3
UNI	0.0	0.0	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
DOM	6.7	11.6	10.3	3.0	3.6	3.5	0.0	1.4	1.2	3.0	5.0	4.7
FOR	26.7	4.7	10.3	6.0	0.5	4.2	0.0	0.0	0.0	6.0	0.5	4.2
AcSc	6.7	0.0	1.7	2.0	n/a	2.0	4.0	n/a	4.0	6.0	n/a	6.0
Other	0.0	2.3	1.7	n/a	8.0	8.0	n/a	0.0	0.0	n/a	8.0	8.0
All	100.0	100.0	100.0	4.9	4.3	4.5	0.5	0.7	0.7	5.4	5.1	5.2

Again, the institutional base of PCT patenting roughly mirrors that of overall Latvian patenting, thus confirming Radošević and Kutlača's (1999) findings regarding a large share of individual patenting in post-socialist economies. When analysing the figures, it is once again important to remember that, unlike Estonia, PCT applications do not mirror inflows, so while the number of PCT applications with a Latvian priority increases, the knowledge inflows actually level off.

Unlike Estonia, Latvia does record PCT patent applications from MNE subsidiaries. In the years 1993 to 1998, all of these applications are filed by firms that also contribute to Latvia's intake of foreign knowledge (Kemira, Merck, Bedminster, Skanska, and ETM) through direct or, in Skanska's case, indirect means[69], a feature unique to Latvian PCT patents. Given that the share of PCT patents filed in Latvia by foreign firms drops from 27% to 5%, there seems to be the same 'disenchantment' as described earlier – either Latvia is attractive as merely a market (or a hub for more eastern markets), or as a location for production-focused rather than R&D FDI.

The rate of self-citation is only slightly higher in Latvia than in Estonia with 0.3 self-citations on average than the 0.27 recorded in the latter. However, Soviet patents are cited four times as often per Latvian patent (0.26), indicating a higher reliance on passed-down knowledge.

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[69] Swedish Skanska does not contribute to the knowledge flows discussed earlier. However, the patent's citations include patents by Swedish firms which were also inflows.

An interesting feature is the role and weight of academia in Latvian PCT patenting. While the overall share of PCT patenting is not very large with no university patents and Academy of Science patents way below 7% and falling, it should be noted that several individual applicants that apply for PCT patents repeatedly (namely Mssrs. Kalvinsh and Veveris) hold posts within the Latvian Academy of Science, Ivars Kalvinsh being the head of the Department of Medicinal Chemistry (LZA 2007). Both also appear on domestic corporate patent applications (Grindeks and Kalvinsh in 2000), Mr. Kalvinsh also being the director of Grindeks at the time (Grindeks 2008). The various patents bearing their names contain self-citations (mostly US and PCT, hinting at prior competitive patents) and national patents across Europe. The patent applications coming from this small group of people and institutions often cite their own work and patents from an Italian pharmaceuticals and life sciences firm, Sigma-Tau S.p.A. While the exact nature of the link between Sigma-Tau and the Latvian group remains unclear, the majority of citations that are neither self-citation nor refer to the inventors' employers cite Sigma-Tau.[70] Furthermore, Grindeks has entered into co-operations with several large pharmaceutical firms that contribute sometimes significantly to Latvia's knowledge inflows, like Merck, Sanofi, Legosan, and the Academy of Sciences as well (Vissak 2002). It seems that a small network has established itself in Latvia, centred on the Academy of Science but including domestic enterprises as well as individual scientists, which succeeds in producing world-class inventions and has done so for some time. Given that there is limited input from out with this network and that no MNE subsidiaries are involved, it seems that Latvia is very much building on indigenous capabilities for the time being, rather than relying on an outside impetus for its development, and thus preserving some strengths developed under Soviet rule well

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[70] This becomes even more pronounced when the second layer of citations is tapped into (i.e. the citations' citations): here Sigma-Tau features almost exclusively with PCT, EP, and GB patents.

into independence (Berengaut and Elborgh-Woytek 2005). A later look at technological specialisations will further support this observation.

As at several points before, least can be said about Lithuanian patenting activities, as Table 7.4 below illustrates.

Table 7.4: PCT patent applications claiming a Lithuanian priority and their citations, summary statistics

	Proportion of PCT Applications (%)			Mean Number of Patent Citations			Mean Number of Document Citations			Mean Number of ALL Citations		
	96-98	*99-04*	*96-04*	*96-98*	*99-04*	*96-04*	*96-98*	*99-04*	*96-04*	*96-98*	*99-04*	*96-04*
IND	60.0	84.6	77.8	6.0	4.8	5.1	0.0	0.4	0.3	6.0	5.2	5.4
UNI	0.0	0.0	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
DOM	0.0	0.0	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
FOR	40.0	15.4	22.2	4.0	4.0	4.0	0.0	0.5	0.3	4.0	4.5	4.3
AcSc	0.0	0.0	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other	0.0	0.0	0.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
All	100.0	100.0	100.0	5.2	4.7	4.8	0.0	0.4	0.3	5.2	5.1	5.1

Only 14 PCT applications are filed between 1996 and 2004, the majority of which come from individual applicants. US patents are not surprisingly most widely cited; however, Lithuania records by far the highest average number of Soviet citations, 0.44 per patent, with a higher overall propensity to cite. Half of these SU patents are cited by a single PCT application (Mr. Narbutas in 1997, the only document that year), two are actually self-citations.

It is impossible to deduct more from these figures than that with respect to PCT patenting, the largest of the three Baltic States seemingly lags some way behind the others despite noticeable increases over time. Again, this relatively weak performance will impact on the Lithuanian results in the following section of this chapter, when PCT and domestic patenting activities are compared and analysed.

7.5 The Technological Profiles of Patenting Activities in the Baltic States

While this chapter is primarily concerned with knowledge generation in the Baltic States, the theoretical framework made it clear that foreign patenting in the region should – through spillovers – influence the developing knowledge economy to some extent. Both through competition and linkage effects can knowledge be transferred from MNEs to indigenous firms in the Baltic States (Markusen and Venables 1999).

The attempt to trace visible spillovers through patent citations in the preceding section has shown that very few of these have happened in the Baltic States so far. However, this does not mean that knowledge spillovers do not exist at all in the three countries. Patent citations document the most explicit spillover possible. Much more intangible ways of passing on knowledge from one person to another exist as well, though. Coming back to Griliches' (1990) notion that patents constitute only a limited portion of the overall knowledge available to the actors within an innovation system, it can be argued that while patents capture this knowledge, they do not have to do so by explicitly citing each other. Accordingly, knowledge that flows into the Baltics through the extension of patents is only one visible share of the overall knowledge entering the host countries. However, the intangible part will be somehow connected to the tangible patent applications, so that if foreign patenting in the Baltics States assumes a particular technological profile, intangible knowledge will follow this pattern to some extent. It stands to reason, then, that patents generated within the Baltic States do not necessarily have to rest explicitly on foreign knowledge, but may 'merely' be filed in the same or similar technological fields, having picked up the implicit part of the knowledge inflows. The argument follows Ozawa's (1996) Flying Geese concept to the extent that it is the exposure to knowledge from abroad that triggers domestic development. This way, spillovers could be witnessed in patenting profiles that mirror those of the patent inflows to some extent.

In the following, exactly this is done. As PCT patenting is still very weak in the Baltic States, both domestic and PCT patenting is examined and compared to the source countries' knowledge inflows in each country.[71] Furthermore, as domestic and international patenting of a country can develop different strengths and weaknesses for several reasons (Paci, Sassu, and Usai 1997), it is reasonable to first have a look at how the Baltic States themselves perform.

7.5.1 The Baltic States' RTA Patenting Profiles: at Home and Internationally

When looking at the domestic and PCT patenting profiles in the Baltic States, it has to be kept in mind the extremely small figures that underlie particularly the international RTA profiles. Estonia only records 27 PCT patent applications in the whole time under analysis, Latvia 42, and Lithuania a paltry 14. Given that Lithuania is the largest country by population, the figure is even less impressive. For the sake of completeness, RTAs have been calculated wherever feasible[72], but even where presented, have to be treated with extreme caution.

Table 7.5 below reports Estonia's relative specialisations in domestic PCT foreign patenting in both time periods.

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[71] Domestic RTAs are, as detailed in Chapter 4, calculated with all national patents (for each Baltic State respectively) in the denominator.

[72] It seems obvious that no RTA profile is presented for Lithuania's PCT patenting in 1992-1998: With only one patent application and eight sections of the IPC that patents can fall into, any kind of index becomes meaningless.

Table 7.5: Estonia's domestic and PCT patenting profiles, 1992-1998, 1999-2004, and lagged

	1992-1998		*1999-2004*		*1992-1998*	*1999-2004*
IPC	**domestic**	**PCT**	**domestic**	**PCT**	**domestic**	**PCT**
A	0.606	0.778	0.566	**1.770**	0.606	**1.770**
B	**1.535**	**2.690**	**2.309**	0.483	**1.535**	0.483
C	0.609	0.707	0.878	0.617	0.609	0.617
D	**3.857**	0	**1.345**	**2.496**	**3.857**	**2.496**
E	**2.815**	0	**2.184**	0	**2.815**	0
F	**1.929**	**2.174**	**3.272**	**2.171**	**1.929**	**2.171**
G	**1.929**	0	**1.772**	**1.647**	**1.929**	**1.647**
H	**1.624**	0	0.592	0	**1.624**	0
corr	-0.32		0.18		0.28	

PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Not surprisingly, the PCT patenting profile is riddled with zeroes, as not enough patents are applied for to populate all IPC sections. This is also one reason that the correlation coefficients are weak throughout. However, while in the previous chapter weak or negative correlations did not automatically mean totally dissimilar RTA profiles, Estonia's domestic and international profiles are quite dissimilar, in the earlier time period even more so than in the later one. It is not surprising that the country records a pronounced strength in the sectors D (textiles and paper) and F (engineering). While the revealed advantage in D is clearly owed to the importance of Estonia's wood and paper industry (Ukrainski and Varblane 2006), the advantage in F (and to a lesser extent E, G, and H) probably mirrors the extensive restructuring that Estonia underwent after its independence.

The picture that emerges for Latvia is surprisingly similar, as Table 7.6 below illustrates.

Table 7.6: Latvia's domestic and PCT patenting profiles, 1992-1998, 1999-2004, and lagged

	1992-1998		*1999-2004*		*1992-1998*	*1999-2004*
IPC	**domestic**	**PCT**	**domestic**	**PCT**	**domestic**	**PCT**
A	0.854	**1.867**	0.867	**2.876**	0.854	**2.876**
B	**1.061**	0.538	**1.274**	0.627	**1.061**	0.627
C	0.722	0.424	0.842	0.668	0.722	0.668
D	0.693	0	0.971	**1.622**	0.693	**1.622**
E	**1.224**	0	0.957	0.829	**1.224**	0.829
F	**1.732**	**1.304**	**1.255**	**2.469**	**1.732**	**2.469**
G	**1.484**	**1.290**	**1.251**	0.134	**1.484**	0.134
H	**2.152**	**1.304**	**1.280**	0.142	**2.152**	0.142
corr	0.44		-0.36		-0.29	

LCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Domestically, revealed advantages in patenting are present in the lower half of the table as well as B (performing operations), similar to Estonia, and therefore making the case for the interpretation that these strengths reflect the extensive restructuring, re-building and upgrading that transition countries go through. Latvia's PCT patenting profile is slightly more stable than Estonia's, possibly simply reflecting the greater number of PCT patent applications that originate in Latvia. The country also develops an international strength in the field of textiles and paper – not surprisingly, as not only are its natural endowments similar to the other two Baltic States, the European Cluster Survey also identifies clusters in these fields of domestic strength in the country (European Commission 2007). While the cluster's innovation rate is classified as low by the Observatory, its strong exports will still encourage incremental, low-key innovation which may manifest itself in domestic patent applications.

It is interesting to note that a finding of the preceding section of this chapter seems to be confirmed: While Latvia exhibits a pronounced relative weakness domestically in the field A (human necessities, which includes medicine and some areas of life sciences), it actually shows a revealed advantage there in its PCT patent applications. It seems the little network around the LZA of the Latvian Academy of Sciences that was identified in the citation examination leaves its mark on the overall technological profile of the country. Neither is it surprising that this strength is not mirrored in the domestic profile: If the LZA has been traditionally making inventions at an internationally competitive level, they would not necessarily take the detour of applying at home first – particularly as the Soviet system did not provide for this strategy.

Turning to Lithuania, whose technological profiles are illustrated in Table 7.7 below, once again a familiar profile emerges.

Table 7.7: Lithuania's domestic and PCT patenting profiles, 1992-1998, 1999-2004, and lagged

	1992-1998		***1999-2004***		***1992-1998***	***1999-2004***
IPC	**domestic**	**PCT**	**domestic**	**PCT**	**domestic**	**PCT**
A	0.774	**1.167**	0.916	**2.655**	0.774	**2.655**
B	0.935	0	**1.250**	0	0.935	0
C	0.831	**1.061**	0.810	0.411	0.831	0.411
D	0.869	0	0.822	0	0.869	0
E	**1.369**	0	**1.113**	0	**1.369**	0
F	**1.403**	**3.261**	**1.300**	**4.342**	**1.403**	**4.342**
G	**1.874**	**1.612**	**1.070**	0.824	**1.874**	0.824
H	**1.541**	0	0.983	0	**1.541**	0
corr	0.26		0.38		0.03	

PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

In Lithuania's case, the PCT profiles can be almost completely neglected, given the far too small numbers of applications.[73] Nevertheless, it is again the lower half of the table that shows revealed technological advantages in domestic patenting.

It is very interesting that, given all the differences that have been found so far between the Baltic States, whether in the strength of patent inflows and their determinants and composition, knowledge generation, or the applicants responsible for both, all three are close to identical in the relative strengths they exhibit in their domestic patenting.

[73] That there is a PCT profile at all for the first time period is due to the multiple counts method of apportioning patents to IPC sections.

This is curious, as the countries are similar only on the surface, as this study has so far shown. What they do have in common, though, is the quite enormous effort of upgrading their infrastructure after they gained independence. The fact that the revealed technological advantages lie in what could be termed physical fields[74] of technology and are often enough purely domestic (i.e. no cutting-edge, internationally competitive knowledge is created) suggests that in this case it is indeed a transition-specific phenomenon that is witnessed. With IP protection regimes only emerging after independence, even relatively minor inventions would have been patented domestically to protect domestic markets and production. It could be argued that the main effort of restructuring and upgrading infrastructure was then initiated, with the necessary patents in place. Another reason may be that the traditional strengths of the Soviet Union S&T S&T system lay in these fields, and the strong RTAs could indicate what could be termed an 'echo' of former specialisations. The nature of the clusters that are identified by the European Cluster Observatory supports this: Most of the clusters listed reflect the Baltic States' domestic, rather than international revealed advantages, with clustering happening in fields such as construction (Lithuania), education (Latvia), apparel (Lithuania), and furniture (all three) (EC 2007).

It would further be interesting to investigate at a later point whether this pattern of domestic specialisation of patenting activities is common across transition economies.

7.5.2 Comparison between Host Countries' domestic and Source Countries' Inward RTAs

Looking at the Baltic States' technological specialisations, both at home and abroad, has provided some interesting insights. However, one central question of this study is

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[74] Physical in this case means fields that can be broadly associated with infrastructure and building projects: performing operations, fixed constructions, mechanical engineering, and ICT infrastructure.

what power foreign actors have to shape and influence the development of the three transition economies. Following the reasoning of both Chapter 4 and the preceding sections, the Baltic States' patenting profiles are now compared with the technological specialisations the source countries develop in their extending of patents to the Baltics. It is the domestic patenting that is analysed first, in accordance with the view presented in Chapter 3 that domestic patenting will develop before PCT patenting. Quite obviously, no completely clear-cut picture can be expected, as the total amount of knowledge available in the Baltic host economy will be a mixture of all inflows and the existent knowledge stock within the country. Still, some insights may be gained.

Table 7.8 and Table 7.9 below present those comparisons for Estonia, again broken down into the two time periods.

Table 7.8: Estonian patenting profiles compared to source countries' inward profiles, 1992-1998

	EE/EE	EE/PCT	SE/EE	FI/EE	DK/EE	NO/EE	US/EE	UK/EE	DE/EE
A	0.606	0.778	**1.172**	0.503	**1.028**	n/a	**1.086**	n/a	**1.005**
B	**1.535**	**2.690**	**1.288**	**1.621**	**1.181**	n/a	0.484	n/a	**1.080**
C	0.609	0.707	0.857	0.557	0.994	n/a	**1.271**	n/a	0.965
D	**3.857**	*0*	0.905	0.588	*0*	n/a	0.239	n/a	**1.765**
E	**2.815**	*0*	0.550	**3.148**	0.894	n/a	0.233	n/a	**1.502**
F	**1.929**	**2.174**	0.950	**2.294**	**1.102**	n/a	0.574	n/a	0.971
G	**1.929**	*0*	0.678	**1.176**	0.918	n/a	**1.077**	n/a	0.809
H	**1.624**	*0*	0.571	**4.087**	0.580	n/a	0.907	n/a	0.372
corr with EE/EE		**-0.32**	-0.33	0.15	-0.72	n/a	-0.82	n/a	0.67
corr with EE/PCT			0.75	-0.10	0.61	n/a	-0.12	n/a	-0.08

EE = Estonia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 7.9: Estonian patenting profiles compared to source countries' inward profiles, 1999-2004

	EE/EE	EE/PCT	SE/EE	FI/EE	DK/EE	NO/EE	US/EE	UK/EE	DE/EE
A	0.566	**1.770**	0.800	0.624	**1.098**	0.109	**1.109**	**1.224**	**1.120**
B	**2.309**	0.483	0.766	**1.843**	**1.707**	**6.420**	0.498	0.814	**1.304**
C	0.878	0.617	0.678	0.533	0.977	0.393	**1.058**	**1.141**	**1.108**
D	**1.345**	**2.496**	0.660	**2.795**	*0*	**9.040**	0.372	0.430	**2.645**
E	**2.184**	*0*	**1.208**	**4.479**	**2.129**	**2.668**	0.128	0.571	**1.301**
F	**3.272**	**2.171**	**1.330**	**2.775**	0.836	**4.712**	0.151	0.896	**1.379**
G	**1.772**	**1.647**	**1.322**	**1.052**	0.792	0.595	**1.085**	0.538	0.445
H	0.592	*0*	**2.295**	**1.406**	0.265	0.332	**1.226**	0.504	0.205
corr with EE/EE		**0.18**	-0.06	0.60	0.38	0.48	-0.80	-0.15	0.22
corr with EE/PCT			-0.39	-0.08	-0.51	0.41	-0.18	0.07	0.54

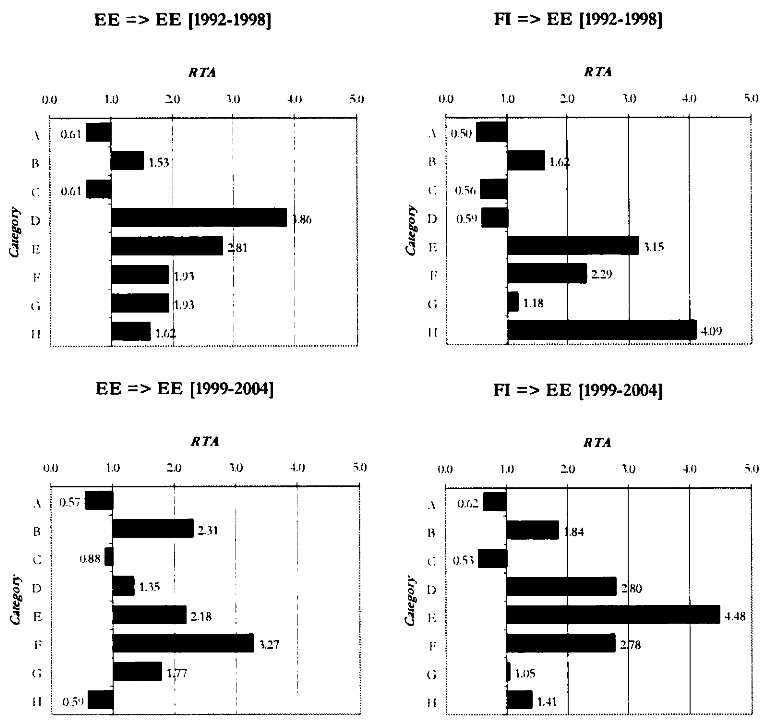
EE = Estonia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

At first sight, the picture is indeed rather mixed, with correlations being either weak or changing signs over time. However, as the preceding chapter demonstrated, correlation coefficients are not enough to identify similarity between RTA profiles. They do give some hints, though. It is interesting to note that the American profile, despite the US being the largest source of foreign patents in Estonia, is completely uncorrelated with Estonia's PCT profile, and even inversely related to the host country's domestic one. This could mean that despite large knowledge inflows, US MNEs are not as deeply involved in the host economy as just these numbers suggest – an interpretation that already emerged earlier in the analysis. If US patenting in Estonia were mainly aimed at arms-length trade rather than any hands-on corporate presence, it would not be surprising to find no or hardly any evidence of Estonian patenting following the US pattern. Indeed, the analysis of knowledge inflows has already hinted at this.

The regression analysis in Chapter 5 also pointed to the importance of distance for foreign patenting in Estonia. When turning to its closest neighbour, Finland, the picture changes accordingly. Despite weak correlation coefficients of 0.15 with Estonia's domestic and -0.1 with its PCT in the earlier time period, the Finnish patenting pattern in Estonia resembles Estonia's domestic profile quite strongly when the amplitude of

RTAs is ignored and only their character is considered. In fact, the only difference is IPC section D (textiles and paper), where Estonia's domestic strength faces a Finnish weakness in inflows. Figure 7.8 illustrates this.

Figure 7.8: Estonia's domestic RTA profile vs. Finland's inward RTA profile, both time periods



In the later time period, this similarity between the profiles increases, which is picked up by the much higher correlation coefficient of 0.6. Again, only one field (this time H – electricity) differs between the profiles and the magnitudes of the RTAs is much more 'harmonised', with pronounced and weak RTA values mostly matching each other. With the US and Finland being at the extreme ends of the distance spectrum and judging merely from patent data, it does seem that proximity does facilitate technological 'nearness', if not outright spillovers. Of course other influences will play a part, like Finland's and Estonia's relatively small home markets and natural resource endowments as well as comparable cultural backgrounds. Still, if Finland and the US are accepted as the two extremes both in their profile 'match' with Estonia and their distance from the host country, it is not surprising that all other source countries show inward technological profiles somewhere between those extremes. Accepting the second time period as the more stable one, Estonia matches Sweden's inflow profile rather well domestically, with five fields taking the same character, whereas the UK is very much like the US in actually showing almost the reversal of the Estonian domestic profile. However, both countries, as well as Denmark and Germany, mirror Estonia's relative strength in the field A – human necessities in its PCT patenting. Given that in the earlier years PCT applications in this field were filed from Estonia but never amounted to a strength (with the available countries already showing marked inward advantages there), one could assume that a catching up indeed happened – but there is little other evidence to support this conjecture.

Turning to Latvia, Table 7.10 and Table 7.11 summarise the country's domestic and PCT patenting profile compared with the source countries' inward RTAs into the country.

Table 7.10: Latvia's patenting profiles compared to source countries' inward profiles, 1992-1998:

	LV/LV	LV/PCT	SE/LV	FI/LV	DK/LV	NO/LV	US/LV	UK/LV	DE/LV
A	0.854	**1.867**	**1.004**	0.648	**1.241**	n/a	**1.249**	n/a	0.703
B	**1.061**	0.538	**1.571**	**2.115**	0.755	n/a	0.503	n/a	**1.803**
C	0.722	0.424	**1.023**	0.680	0.737	n/a	**1.294**	n/a	0.870
D	0.693	0	**3.203**	**2.128**	**1.064**	n/a	0.173	n/a	**2.481**
E	**1.224**	0	0.960	**1.754**	**3.070**	n/a	0.143	n/a	**1.925**
F	**1.732**	**1.304**	0.404	**2.068**	**1.181**	n/a	0.432	n/a	**1.504**
G	**1.484**	**1.290**	0.188	0.686	0.343	n/a	0.947	n/a	**1.082**
H	**2.152**	**1.304**	0.306	0.746	0.373	n/a	0.364	n/a	0.512
corr with LV/LV		**0.44**	-0.69	-0.12	-0.20	n/a	-0.34	n/a	-0.39
corr with LV/PCT			-0.63	-0.55	-0.44	n/a	0.50	n/a	-0.75

LV = Estonia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineeing, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 7.11: Latvia's patenting profiles compared to source countries' inward profiles, 1999-2004

	LV/LV	LV/PCT	SE/LV	FI/LV	DK/LV	NO/LV	US/LV	UK/LV	DE/LV
A	0.867	**2.876**	0.827	0.890	**1.447**	n/a	**1.477**	n/a	0.624
B	**1.274**	0.627	0.616	0.663	**1.078**	n/a	0.243	n/a	**1.521**
C	0.842	0.668	0.282	*0*	0.494	n/a	**1.627**	n/a	0.542
D	0.971	**1.622**	*0*	**7.011**	*0*	n/a	0.642	n/a	**5.361**
E	0.957	0.829	**3.851**	**2.765**	**2.246**	n/a	0.063	n/a	**2.114**
F	**1.255**	**2.469**	*0*	**4.462**	**1.813**	n/a	0.051	n/a	**2.275**
G	**1.251**	0.134	**2.486**	*0*	*0*	n/a	0.163	n/a	0.910
H	**1.280**	0.142	**2.250**	**1.212**	*0*	n/a	0.333	n/a	0.927
corr with LV/LV		**-0.36**	0.11	-0.08	-0.19	n/a	-0.77	n/a	-0.08
corr with LV/PCT			-0.51	0.44	0.49	n/a	0.30	n/a	0.23

LV = Estonia(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Interpreting these results is much more difficult, as they are much weaker than Estonia's. Given that Latvia experiences the peak of knowledge inflows in the first period but more patents are applied for, at least internationally later on, not much can be concluded with certainty. What is more, the RTA profiles are quite disconnected, with neither profile matching any source country's inward patenting closely.

It is interesting, though, that Latvia's pronounced strength in field A (human necessities) mirrors that of the US and Denmark (and Sweden in the earlier years). The US is once again the biggest contributor to Latvia's knowledge inflows, but it is also there that internationally competitive patents were filed before the PCT patent became the international patent of choice. The small network of applicants for life sciences patents in Latvia would have, in Soviet times, had some insight into US patents, as well as receiving a large patent inflow from leading US pharmaceutical MNEs. Given Latvia's connection with the US through its expatriate community there, it seems possible that there is indeed a link, although whether Latvia's current strength is built on spillovers or purely a continuation of historical performance can not be safely said. There seem to be efforts, though, to build on these successes. In 1996 (ironically the year that knowledge inflows into Latvia started to level off), the Association of

International Research-based Pharmaceutical Manufacturers (AFA) was founded, which aims to support the sector by fostering knowledge exchange, co-operation between actors and the general healthcare sector in Latvia. Among its members are pretty much all the pharmaceutical companies that contributed to knowledge inflows (AFA 2009).[75] Whether this organisation will contribute to Latvian knowledge generation significantly, remains to be seen.

Another observation is Latvia's revealed advantage in PCT patenting with respect to the field D (textiles and paper), where it matches marked inflow strengths of Germany (2.481 and 5.361) and Finland (2.128 and 7.011). The much stronger RTAs both source countries show in the later time period is at least partly owed to the much smaller inflows underlying these indices, but even in the early years the RTAs are rather large. While Finland has a strong forest cluster, Germany does not – although that could also be due to Germany simply having even stronger regions or clusters in other fields (EC 2007). Nevertheless, Latvia seems to have been able to upgrade its own forest sector enough to produce PCT-worthy inventions there, which could have been helped significantly by patents from those two source countries.

Where conclusions are difficult to draw for Latvia, the picture becomes even more scant in Lithuania, where almost no international competitive inventions are patented through the PCT. The country's RTA profiles and the inward profiles are reported in Table 7.12 and Table 7.13 below.

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[75] Members as of 2009 are: Abbott Laboratories S.A.; AstraZeneca; Bayer Schering Pharma AG; Berlin-Chemie/Menarini; Biotest Pharma, Boeringer Ingelheim; Bristol Myers Squibb; Eli Lilly; Ferring Pharmaceuticals, Gedeon Richter; GlaxoSmithKline; Ipsen; Janssen; Kaken Pharmaceutical, LEO Pharmaceutical Products, Lundbeck; Merck; Merck Sharp & Dohme; Nippon Kayaku; Novartis Vaccines; Novo Nordisk; Nycomed; Orion Corporation; Pfizer; Roche; Sanofi-Aventis; Servier International; Schering – Plough, UCB Pharma.

Table 7.12: Lithuania's patenting profiles compared to source countries' inward profiles, 1992-1998

	LT/LT	LT/PCT	SE/LT	FI/LT	DK/LT	NO/LT	US/LT	UK/LT	DE/LT
A	0.774	**1.167**	**1.065**	n/a	n/a	n/a	**1.287**	n/a	0.791
B	0.935	*0*	**1.213**	n/a	n/a	n/a	0.624	n/a	**1.699**
C	0.831	**1.061**	**1.057**	n/a	n/a	n/a	**1.268**	n/a	0.856
D	0.869	*0*	**2.058**	n/a	n/a	n/a	0.118	n/a	**2.175**
E	**1.369**	*0*	0.607	n/a	n/a	n/a	0.232	n/a	**1.655**
F	**1.403**	**3.261**	0.244	n/a	n/a	n/a	0.672	n/a	0.962
G	**1.874**	**1.612**	**1.090**	n/a	n/a	n/a	0.900	n/a	0.410
H	**1.541**	*0*	0.377	n/a	n/a	n/a	0.346	n/a	0.849
corr with LT/LT	**0.26**		-0.51	n/a	n/a	n/a	-0.25	n/a	-0.46
corr with LT/PCT			-0.42	n/a	n/a	n/a	0.46	n/a	-0.56

LT = Lithuania(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Table 7.13: Lithuania's patenting profiles compared to source countries' inward profiles, 1999-2004

	LT/LT	LT/PCT	SE/LT	FI/LT	DK/LT	NO/LT	US/LT	UK/LT	DE/LT
A	0.916	**2.655**	0.273	n/a	n/a	n/a	**1.516**	n/a	0.733
B	**1.250**	*0*	0.710	n/a	n/a	n/a	0.340	n/a	**1.042**
C	0.810	0.411	0.835	n/a	n/a	n/a	**1.722**	n/a	0.816
D	0.822	*0*	*0*	n/a	n/a	n/a	**1.053**	n/a	**4.307**
E	**1.113**	*0*	**3.477**	n/a	n/a	n/a	0.069	n/a	**1.983**
F	**1.300**	**4.342**	*0*	n/a	n/a	n/a	0.125	n/a	**1.282**
G	**1.070**	0.824	**2.097**	n/a	n/a	n/a	0.439	n/a	0.769
H	0.983	*0*	**3.388**	n/a	n/a	n/a	0.101	n/a	0.828
corr with LT/LT	**0.38**		0.06	n/a	n/a	n/a	-0.77	n/a	-0.29
corr with LT/PCT			-0.51	n/a	n/a	n/a	0.02	n/a	-0.26

LT = Lithuania(n patent regime), SE = Sweden, FI = Finland, NO = Norway, US = United States, UK = United Kingdom, DE = Germany, PCT = Patent Cooperation Treaty/ "international patent" regime, and IPC = International Patent Classification with A = Human Necessities, B = Performing Operations, Transporting, C = Chemistry, Metallurgy, D = Textiles, Paper, E = Fixed Constructions, F = Mechanical Engineering, Lighting, Heating, Weapons, Blasting, G = Physics, H = Electricity

Not only does Lithuania generate hardly any PCT patent applications, it also receives the fewest patent extensions from abroad. The few inward RTA profiles that can be computed are hardly matched by Lithuanian patenting – although the country's domestic specialisations do mirror Germany's inward profile to some extent. Given the near-complete disappearance of knowledge inflows in the later years, this does not necessarily imply a factual link between the two.

The finding is not surprising, though, when all prior findings regarding Lithuania are taken into account. The data underlying all parts of the analysis are the thinnest of the three countries, combined with a very real lack of significant inventive activity. It is once again striking that the largest country of the Baltic rim seems to find it hardest to get its knowledge economy started.

7.6 Conclusions

This chapter aimed at giving a detailed analysis of the patenting dynamics in the Baltic States and to examine whether patenting activities within the three countries can be at least to some extent assigned to the existence of knowledge spillovers from patent inflows, thus assessing the validity of the IDP/ TDP considerations in the context of transition economies.

Not surprisingly, the Baltic States lag behind the highly innovative and knowledge-driven source countries that contribute most to knowledge inflows. It is an intriguing finding that domestic knowledge creation follows broadly the pattern of inflows, with the numbers in Latvia and Lithuania falling after an initial surge. Despite this, it is interestingly those two countries that record more domestically generated patent applications than Estonia, which seems to take an almost passive role. A possible explanation for this is a different approach to national knowledge 'management', with Latvia and Lithuania's governments (and citizens!) taking a more self-contained or self-reliant take on S&T management. Estonia's government, the country being the smallest of the three, might be aware of its limited knowledge base, no matter how innovative its economy is in absolute terms. Yet the observation also confirms Kurik's et al. (2002) finding that there is relatively little innovation in Estonian firms overall.

As expected, this lagging behind is even starker with respect to PCT patent applications. However, the number of applications is rising, indicating that – albeit slowly and from the lowest starting point possible – the Baltic States are developing potential for internationally competitive knowledge creation. This notion of a transition taking place in the S&T system of the countries is also found in the fact that the institutional base of patenting is slowly changing towards a more western composition – although it is again Estonia which is clearly ahead of the other two countries.

Taking the similarity between the Baltics States' RTA profiles (both domestic and internationally) and those the source countries develop within the three host countries as a proxy for spillovers and the Baltics' ability to take in the foreign knowledge, it seems that Estonia does best in this. While there are no outright matches (which are unlikely anyway, given that there are several source countries), the country does mirror knowledge inflows slightly better than the other two do. This is somewhat consistent with the countries' rankings in the Global Competitiveness Reports, where Estonia scores continuously higher when technology absorption is concerned (WEF 2002, 2004, 2005). Latvia, on the other hand, does not only score lower, but Watkins and Agapitova (2004) point towards particular weaknesses in the Latvian NIS that make it difficult for Latvian companies to absorb and utilise foreign knowledge, such as a lack of access to funding and a failure to attract FDI to knowledge and technology intensive sectors of the economy. Lithuania, being the weakest country with respect to knowledge generation, has little to be compared with respect to RTA profiles. The EC (2005b) seems to be correct in that the Lithuanian NIS lags behind the other two countries in almost every respect, and that while the formal institutions are in place, it is a lack of funds and co-ordination that makes the system weak and barely integrated. The clusters identified (EC 2007) are most probably a result of the methodology applied in the Cluster Survey, rather than actual hotspots of innovation. While the innovation scoreboard (EC 2005b) rates Lithuania as 'catching up', it has to be kept in mind that the country is quite obviously starting from a very low position.

In conclusion, it can be said that while there is growing patenting activity in the Baltic States and some networks of people and organisations could be identified, the countries are nowhere near a fully-fletched innovation system envisaged in Chapter 3. This was not expected, though, and the findings are encouraging in that they point to the development of innovative capacity in the Baltic States, which, if nurtured, has ever potential of evolving into a knowledge-based economy.

CHAPTER 8

SUMMARY, CONCLUSIONS, AND OUTLOOK

8.1 Introduction

This study presents an in-depth analysis of knowledge flows, generation, and spillovers in the three Baltic States Estonia, Latvia, and Lithuania within the context of transition economies aiming to build knowledge-driven economies. By combining several distinct approaches to examining the phenomenon of patenting dynamics at different stages of the knowledge production function and from different angles, the question whether the Baltic States develop innovative capacity in the course of their transition process is assessed and the possible emergence of innovation systems analysed. This final chapter looks back at the study in its entirety, summarises the findings and presents conclusions concerning the findings, the contribution the study makes to the existing body of knowledge, and highlights opportunities for further research.

8.2 Summary of Findings

The Baltic States and their transition from Soviet republics to EU member states and thus from a command to a market economy present a unique opportunity for a comparative country study. The particular focus of this study lies on the possibility of creating an innovation system of some kind (whether regional, sectoral, or national) that forms a basis for a knowledge-based economy, which is essential of maintaining sustained growth once cost-derived competitiveness wears off through rising national income. Following the considerations of the IDP model and incorporating intangible assets, namely knowledge codified in patent applications, as well as the concepts of proximity as a facilitator of spillovers and a systems approach, this study uses knowledge as the main focal point for examining the development of the Baltic States.

In the first part of the analysis in Chapter 5, a panel data analysis is used to test the assumptions that knowledge flows to the Baltic States in the form of patents is indeed facilitated by the presence of FDI and/ or trade, geographical proximity between source and host country, and the innovative capacity of the source countries themselves, as was elaborated in chapters 3 and 4. It seems to be the case in Estonia, where the results indicate that knowledge inflows do indeed depend on proximity and FDI, although trade plays a bigger role than FDI. As the trade and FDI variables are not surprisingly correlated, this is not counterintuitive, given the early stage of transition the Baltic States are still in. It is however reassuring that Estonia 'conforms' to the model developed and benefits from its rapid opening to MNE activities. It also emphasises the Estonian integration into the wider Baltic Sea region, with Finland and Sweden being the biggest sources of FDI in the country. In Latvia, the emerging picture is far less clear. It seems puzzling at first sight that FDI and trade should hinder knowledge inflows, while a greater distance between Latvia and the source countries promotes them. However, with the US being a major player in Latvia's development through a large Latvian expatriate community and Germany outpacing the closer-by Nordic countries in FDI and trade. Furthermore, the Latvian data fits a linear regression model less well than the Estonian data does, with the trends of knowledge inflows only matching those of FDI and trade in the earlier years of transition, before they reverse. In the Lithuanian case, the data are too weak to produce any meaningful result, as Lithuanian knowledge inflows virtually collapse in the later years under investigation, while FDI data only becomes available from 1997 onwards.

The second stage of the analysis, presented in Chapter 6, focuses on the knowledge inflows themselves, their strength, composition, and embodied technology being examined. One of the most immediate and striking observations is the stark difference between the three Baltic host economies. While in Estonia, knowledge inflows grow slowly but steadily over the years, they surge in the first few years of transition and then trail off significantly in the other two countries. The absolute strength of flows from Sweden and Finland in particular is also interesting, given the relatively small size of the two countries compared to other source countries. While all three Baltic States seem to receive a share of the knowledge inflows in the form of indiscriminate international extension of foreign patents, Estonia seems to be the one host country that manages best to also attract patents specifically targeted at its economy. Obviously building on past strengths and extreme openness, the country has the closest matches between its own patenting profile and that of inflows coming from abroad, suggesting the existence of factors that pull knowledge into the country. It is interesting to note, however, that in most cases, the strongest sources of patent extensions are not the largest investors in the Baltic States. Additionally, the proposition that proximity matters when transferring knowledge is again confirmed, with closer source countries showing more targeted knowledge inflows, rather than just indiscriminately internationalising their IP.

Turning to the assumption that knowledge transferred to the Baltic States will eventually spill over and shape at least to some extent the patenting activities in the Baltic States, Chapter 7 then looks at knowledge generation within the countries, both by foreign and indigenous applicants. Not surprisingly, the Baltic States lag behind the highly innovative and knowledge-driven source countries that contribute most to knowledge inflows. It is an intriguing finding that domestic knowledge creation follows broadly the pattern of inflows, with the numbers in Latvia and Lithuania falling after an initial surge. All countries still record a high share of individuals' patent applications, which is not surprising given their Soviet legacy, although this share is decreasing gradually over time. The citation analysis shows that the countries also differ in the prior knowledge patent applicant rely upon. While the evidence suggests that Estonia is the country that relies on foreign knowledge and only rarely preserves knowledge from its past, in Latvia it is precisely preservation and cross-citations within a relatively small group that characterises the paper trail of inventions. When more indirect spillovers are considered through the comparison of source countries' inward RTAs with the Baltics domestic and international specialisations, it is once again Estonia that emerges as the most receptive to foreign knowledge, with its profile matching that of its closest source country quite well.

To conclude and to answer the central question this study seeks to answer, is has to be stated that there are no innovation systems in the Baltic States, at least not in the sense that the innovation literature envisages.[76] Yet with respect to their emergence, the picture looks more positive, at least in Estonia and Latvia.

While the sectoral innovation system identified in the literature that exists in Estonia cannot be verified by the patenting activity in this sector, it might well develop once Estonian firms rely more strongly on in-house innovative efforts. Most case studies place any innovation system or cluster (whether telecommunication, wood, or fisheries) in Estonia into an early stage of development and mainly responsive rather than strongly innovation driven. The results of this study confirm this, identifying Estonia as the

[76] Once again the difference between the EC's definition of a NIS and that of the literature has to be stressed: Every country has an NIS in the EC's definition, which can then be assessed as to its working. The concept used in academic literature differs from that with respect to the functioning – an innovation system is characterised by exchange and co-ordination, resulting in spillovers between the actors.

country seemingly most attractive and responsive to foreign knowledge inflows. Given time and continuous efforts on behalf of all parties involved, Estonia might well become a highly innovative economy with clusters as the driving force behind sustained growth.

Latvia's National Programme for Innovation was only implemented in 2003, so that its impact on Latvia's innovation performance as studied here will be minimal at best. As such, this study looks at a nascent NIS and has been able to confirm findings from other sources which have looked at Latvia's NIS from different angles.

Lithuania, the largest country of the three, with – on the surface – a rather advantageous starting position (regarding its social structure, educational level, and market size) not only receives the smallest knowledge inflows, it is also persistently lagging behind the other two with respect to patenting activities and furthering of readily available prior knowledge. This is somewhat curious, but confirms the EC's suggestion that while technically in place, the Lithuanian NIS suffers from a lack of general funding and co-ordination of activities and actors (EC 2005b).

8.3 Reconsidering the Aim and Objectives of this Study

The overall aim of this study is to provide an assessment of the Baltic States' development of innovative capacity and its dependence on inward FDI and knowledge flows in the shape of a comparative country study. It has achieved this, presenting an in-depth and concise analysis of the knowledge flows in the Baltic rim. In this, it is probably the most comprehensive study of its kind, tracing the knowledge inflows from major source countries of FDI (and knowledge) to the three Baltic States and the whole complex of knowledge generation, as proxied through patent applications, within the three host countries.

By constructing a multi-dimensional patent database that captures virtually every patent application and its specific characteristics that was filed in the Baltic States between 1992 and 2004, it has created a bit of its own 'knowledge stock', on the basis of which a most detailed examination of the developments could be conducted. The patent database adds in itself to the body of knowledge, as it provides possibilities for analysis that the large online patent databases of the major patent offices can not match due to the construction of their search masks.

This study has investigated several research questions, the main ones being:

- What are the determinants of knowledge inflows to the Baltic States, in other words, do knowledge inflows depend on other factors, like FDI, proximity, or innovativeness of the source country?
- What characterises these knowledge inflows to the Baltics? Who extends patents to the Baltic rim and what knowledge appears to be worth protecting there? And are these inflows specifically targeted at the Baltic States, or are they merely part of a more general internationalisation of commercially viable knowledge?
- What are the patenting dynamics in the Baltic States? Who applies for patents, and is there a transition from typically Soviet patterns of knowledge creation to more 'western' ones? Do the Baltic States develop specialisations and technological expertise of their own? Do spillovers from inflowing knowledge to Baltic indigenously created knowledge happen? Do the Baltics 'learn', do they catch up to at least some extent with the rest of the industrialised world?

All these questions have been examined in detail and, with the possible exception of Lithuania due to a lack of available data, answered as fully as the data permits.

8.4 Contributions of the Study

As for the specific contributions this study makes to the existing body of knowledge, Chapter 3 laid out three of them that were to be made in the course of the investigation. Firstly, the theory of the IDP was to be applied to the specific case of transition economies that have already come some way along their restructuring. This has been done through an extensive analysis of knowledge flows around the Baltic rim, in which the general premises of international inputs being able to aid development in the transition economy was tested.

Secondly, this study has included the concept of the importance of proximity in the analysis, thus specifically exploring the relationship between host and source country and furthering the understanding of international knowledge flows. It has stressed the importance of geographical, technological, cultural, and economic proximity to the transfer of knowledge and highlighted its different dimensions and their interplay.

And thirdly, it has successfully included intangible assets, namely the innovative output in the form of patent applications, into the theory of the IDP. It had been argued before that this inclusion would benefit the IDP model significantly and while patent applications are but one measure of intangible assets, this study has succeeded in integrating them into the model.

As a more practical contribution, this study has highlighted the importance of well-maintained channels of knowledge transfer to benefit from knowledge inflows, both as a firm and a transition economy as a whole. Even if the domestic knowledge stock within an economy is low, it is worthwhile to aim policies at the functioning of the NIS, as the EC defines it. Once the fundamentals are in place, innovative firms (or those eager to learn) should find a way to utilise the knowledge that flows into the host country.

8.5 Limitations and Recommendations for further Research

Obviously, any study can only be as good as the data it is based on and the theoretical considerations these data can capture. While patent data are complete and systematic (lags that cause the data for 2004 to be still incomplete aside), it is particularly the availability of FDI data that limited the analysis. The lack of FDI data broken down by source country was especially disappointing, but it remained beyond the possibilities of this project to obtain bilateral FDI flows for all Baltic States from only one source, as was possible with trade data (which came from the UN's Comtrade database). Although the data is consistent within each regression model presented in Chapter 5, the comparison between the countries, while generally no problem, could be slightly affected by it.

This study is necessarily limited in its scope. As it only uses few variables, it naturally restricts its view of the Baltic States' development. By focusing on patent applications as a proxy for innovative output, it ignores the input side of innovative efforts, such as R&D, as well as the general basis for knowledge creation, such as education of the workforce, progress in production capability, and ICT infrastructure. It would be interesting if comparable research which uses innovation input variables will reach similar conclusions as this one.

Furthermore, the methodology used in this study could be relatively easily applied to other transition (or developing) countries and the results compared across more countries than just the Baltic States. A third recommendation is to apply this or a similar methodology to different sectors (in one host country or again across countries) in order to gain deeper insights into sectoral and industry development, an area necessarily central to the study of clusters.

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